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DEPARTMENT OF THE ARMY TECHNICAL MANUAL

OPERATION AND MAINTENANCE
RANGE CALIBRATOR SET
AN/UPM-11A



HEADQUARTERS, DEPARTMENT OF THE ARMY
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USAR: None.

For explanation of abbreviations used, see AR 320-50.

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Figure 1-1. Range Calibrator Set AN/UPM-11A

SECTION I
DESCRIPTION

1-1. INTRODUCTION.

1-2. **PURPOSE AND SCOPE OF HANDBOOK.** This handbook contains service instructions for the Range Calibrator Set AN/UPM-11A (Air Force Stock Number 7CAC-170276-75) (figure 1-1). This equipment is manufactured by the Farnsworth Electronics Company of Fort Wayne, Indiana.

1-3. GENERAL CHARACTERISTICS.

1-4. Range Calibrator Set AN/UPM-11A (figure 1-1) consists of a transit case, FAR-900714-1 (figure 1-2), the Range Calibrator TS-738A/UPM-11A (figure 1-3) and the accessory equipment contained in the cover of the transit case.

1-5. **PURPOSE OF EQUIPMENT.** The Range Calibrator provides a means of accurately calibrating the ranging circuits, checking the beacon circuitry and collimating the antenna of pulsed X-band radar systems. The calibrator simulates a series of radar targets. The spacing of these targets is determined by an interchangeable ultrasonic delay line. The first target appears at a range approximately equal to the range delay of the calibrator while each succeeding target appears at ranges approximately equal to the odd numbered multiples of this range delay. On RADAR operation, the output of the Range Calibrator is at the same frequency as the radar under calibration; on BEACON operation, the output of the Range Calibrator is at 9310 mc, the frequency of X-band radar beacons. The Range Calibrator may be used either in the field or in a depot repair shop.

1-6. DESCRIPTION.

1-7. Transit case, FAR-900714-1, is of aluminum plymetal construction, finished in light grey enamel. The case has a nondetachable cover secured by eight hinged clamps (10, figure 1-2); two clamps serving as the back hinge of the case. A rubber gasket installed in the cover makes the case water tight. The accessories listed in TABLE I are mounted in the cover of the case. A U-shaped mounting rack is attached to the inside of the case by four shockmounts (12, figure 1-2). This rack is used to mount the Range Calibrator in the case. Two knurled nuts on swivel bolts (11, figure 1-2) secure the Range Calibrator to this rack. Provision is also made in the case for instruction book storage (13, figure 1-2).

1-8. The Range Calibrator consists of eight major assemblies. These are the Front Panel and Associated Controls, RF Assembly, Radar AFC Chassis, Beacon AFC Chassis, 40-Mc Amplifier Chassis, Power Supply Chassis, Delay Line and Oven Assembly and the instrument case incorporating the Fan and Heater Deck Assembly. All assemblies can be

removed and replaced for ease in maintenance and service. All operating controls, the input power connection and the r-f output waveguide are located on the front panel. The instrument case assembly is secured to the front panel by eight captivated screws (2, figure 4-1). A rubber gasket seals the front panel and the instrument case to make the equipment splash proof.

1-9. The antenna horn, FAR-801268-1 (14, figure 1-2), is of cast aluminum painted grey. It has a horizontal and vertical beam width of 20 degrees.

1-10. Two waveguide-to-coaxial-cable adaptors are supplied, the UG-591/U (5, figure 1-2) and the UG-592/U (6, figure 1-2). These are similar except that the UG-591/U is terminated in a cover flange while the UG-592/U is terminated in a choke flange. Both connectors are terminated in type-N fittings to allow interconnection between waveguide and coaxial cable. These assemblies are painted with light grey enamel.

1-11. Waveguide assembly, CG-673/U (9, figure 1-2), is used in conjunction with the antenna horn, FAR-801268-1. This waveguide assembly, CG-673/U, is used to convert the normal H-plane polarization to E-plane polarization. A quick-disconnect clamp, UG-590/U (17, figure 1-2), enables the operator to quickly connect the antenna horn to this assembly. This assembly is painted with light grey enamel.

1-12. Clamp, UG-590/U, is a quick-disconnect clamp painted light grey which is used to connect two pieces of waveguide together.

1-13. Power cable assembly, CX-1490/U (2, figure 1-2), is a 15-foot power cord used to connect the Range Calibrator to the source of primary power which should be 115 volts, 50 to 800 cps, single phase. Required power is 250 watts.

1-14. Cord, FAR-702169G1 (7, figure 1-2), is an eight-foot length of RG-9 type coaxial cable terminated in type-N fittings. It is used in conjunction with the two coaxial-to-waveguide adaptors to connect the antenna horn to the Range Calibrator. It is also used to connect the Range Calibrator to the directional coupler of the radar.

1-15. Measuring tape, TL-598/U (4, figure 1-2), is a thirty-three yard (30 meters) steel tape calibrated in yards and meters. It is used to measure the distance between the radar set and the antenna horn as outlined in paragraph 4-9. The measuring tape is housed in a simulated leather plastic case.

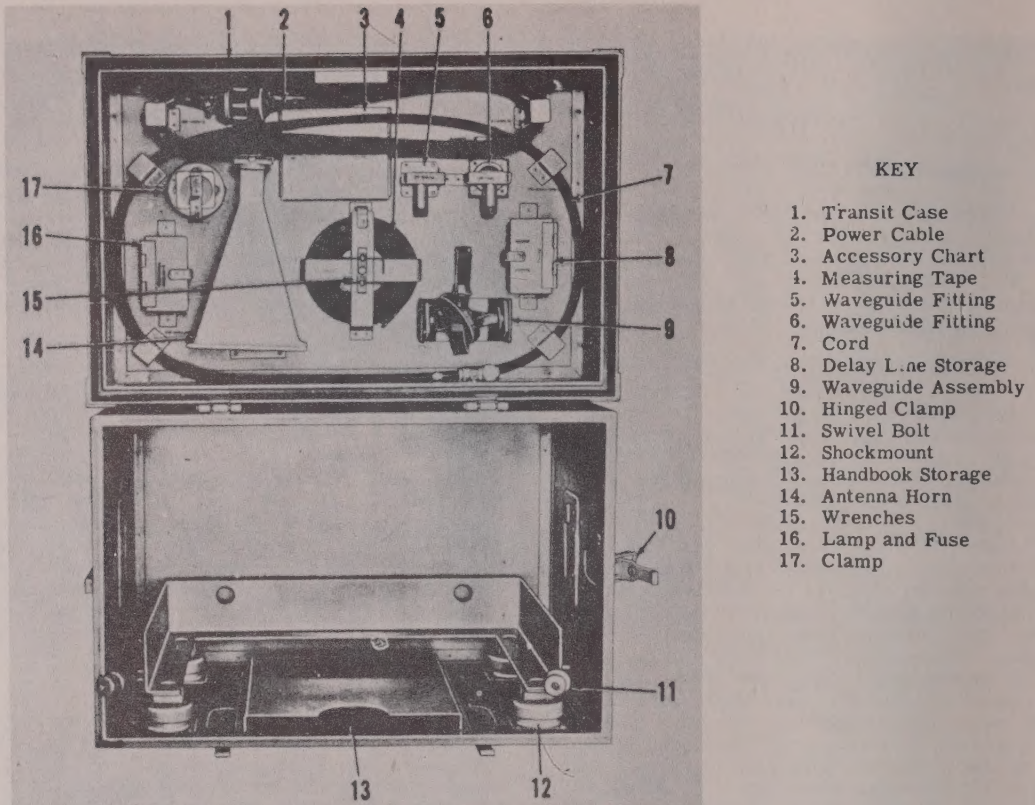


Figure 1-2. Transit Case FAR-900714-1

1-16. Three wrenches (15, figure 1-2) are supplied for disassembly of some units of the Range Calibrator Set AN/UPM-11A. These are standard No. 4 and No. 6 Allen-head socket wrenches.

1-17. Two spare indicator lamps and ten spare fuses are supplied with the equipment. They are contained in a hinged metal box (16, figure 1-2) attached to the transit case cover.

1-18. The weight of the complete equipment is 110 pounds. The Range Calibrator weighs 60 pounds. The dimensions of the transit case are 22 inches wide, 19 inches high and 15 inches deep. The front panel of the Range Calibrator is drilled for standard relay-rack mounting. The panel dimensions are 19 inches wide by 12-1/4 inches high. Depth behind the panel for the instrument case is 13 inches.

1-19. PRINCIPLES OF OPERATION.

1-20. GENERAL. The general block diagram of the Range Calibrator is shown in figure 1-4. The schematic diagrams of the individual units of the Range Calibrator are shown in figure 1-5 through

figure 1-10. Reference should be made to these figures to follow the circuit description.

1-21. The Range Calibrator is an electronic device that provides r-f echo pulses. These echo pulses are used to calibrate the ranging circuits, check the beacon circuitry and collimate the antenna of pulsed radar systems operating in the X-band from 8600 to 9500 mc. The Range Calibrator can be used with X-band radars having power outputs from 5 to 250 kilowatts peak, pulse widths of 0.3 to 3.0 microseconds, pulse repetition rates of 300 to 3000 and average duty-cycle products of 0.0006 to 0.0012. The minimum input r-f power to the Range Calibrator is 35 microwatts average. The transmitted pulse from the radar system is introduced into the Range Calibrator and for each input pulse, a series of return echo pulses are generated in the Range Calibrator and transmitted back to the radar system. These r-f echo pulses have the same general shape as the input pulse and appear as spaced simulated targets. The spacing of these simulated targets is determined by the particular ultrasonic delay line installed in the Range Calibrator.

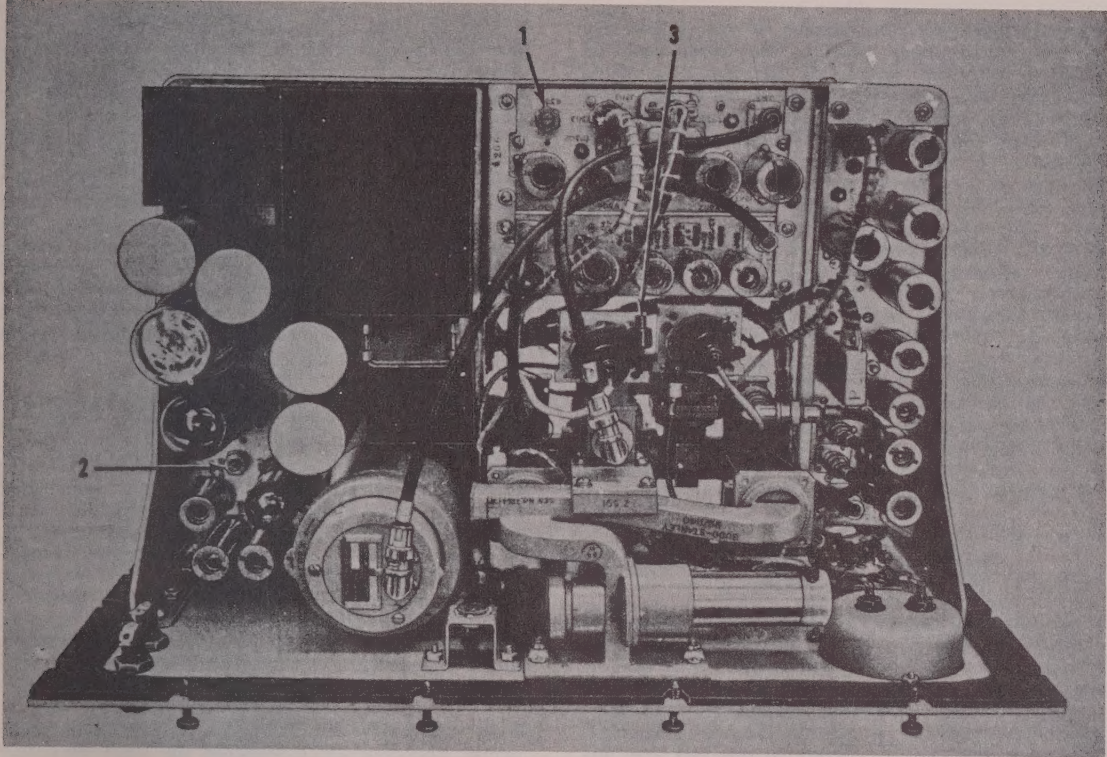


Figure 1-3. Range Calibrator TS-738A/UPM-11A

KEY

1. Beacon L. O. Repeller Voltage Adjust (R-330)
2. 300 Volt Adjust (R-113)
3. Beacon L. O. Coarse Tuning

1-22. BLOCK DIAGRAM DESCRIPTION, figure 1-4. The input radar pulse is connected to the waveguide input of the Range Calibrator either through the antenna horn, FAR-801268-1 (14, figure 1-2), or the cord, FAR-702169G1 (7, figure 1-2), connected to the directional coupler on the radar. This pulse is fed through a directional coupler to the balanced afc mixer section. In the afc mixer section the attenuated radar pulse is mixed with the cw output of the radar local oscillator tube which is tuned 40 mc lower in frequency than the incoming radar pulse. The resultant 40-mc pulse from the afc mixer is fed to the Radar AFC Chassis. The Radar AFC Chassis maintains the frequency of the radar local oscillator tube 40 mc lower than the input radar signal. From the Radar AFC Chassis this 40-mc pulse is fed to the ultrasonic delay line. The 40-mc pulse is used to shock excite the ultrasonic delay line. The first output pulse of the delay line is delayed in time by the delay of the delay line. In addition to this de-

layed pulse, a series of pulses, separated by approximately twice the delay of the line, appear at the output of the delay line. This train of pulses is applied to the wide band 40-mc amplifier. These amplified pulses are then fed into the signal-modulator crystal in the modulator-mixer section of the R-F Assembly. The modulator-mixer combines the amplified delayed pulses with the output of the radar local oscillator. This mixing process produces sideband-frequency signals which are 40 mc above and below the local oscillator frequency. Since the local oscillator is tuned 40 mc lower than the input radar signal, one of these sideband-frequency signals is at the same frequency as the input radar signal, while the remaining sideband-frequency signals are 80 mc below the input radar signal. Both of these sideband-frequency signals are fed through the TR-tube and out through the waveguide to the radar set. This series of delayed r-f signals appears on the radar scope as a series of artificial targets. In

BEACON operation the delayed 40-mc pulses are generated in the same manner. However, when the RADAR - BEACON switch (12, figure 4-1) is in the BEACON position, the r-f output of the beacon local oscillator tube is fed to the modulator-mixer section of the R-F Assembly. The Beacon AFC Chassis maintains the frequency of the beacon local oscillator tube at the reference-cavity frequency of 9350 mc. Thus, the frequency of the beacon local oscillator fed into the modulator-mixer section is 9350 mc. The mixing action within the modulator-mixer section of the delayed 40-mc signals and the 9350-mc beacon local oscillator again produces sideband-frequency signals which are at 9310 and 9390 mc. The 9310-mc signal is the one corresponding to the X-band beacon signal. Both of these sideband-frequency signals are fed through the TR-tube and out through the waveguide to the radar set. The radar set must be on BEACON function to receive the beacon output of the Range Calibrator. Again, the series of delayed r-f signals appears on the radar scope as a series of artificial targets.

1-23. CIRCUIT DESCRIPTION.

1-24. R-F ASSEMBLY, figure 1-5.

1-25. The R-F Assembly contains those microwave components which are used to convert the input microwave signals to 40-mc signals and then to convert the delayed 40-mc signals back to microwave signals at either the radar or beacon frequency. It is composed of a number of mechanical assemblies or rigid waveguide and fittings. These assemblies are: the input waveguide section, the afc mixer, the radar local oscillator mount, the radar-beacon switch, the modulator-mixer, the beacon local oscillator mount, the beacon reference cavity and the beacon crystal mount. Balanced magic-T mixers are used throughout the R-F Assembly.

1-26. The input microwave signal from the radar is introduced into the Range Calibrator through the input waveguide section. Attached to the input waveguide section is the shutter assembly, E-501. When the Range Calibrator is not energized, this shutter is closed and polyiron core, AT-501, is inserted in the waveguide to protect the crystals in the R-F Assembly. In the closed position this shutter has effectively 40 db insertion. When the Range Calibrator is energized the solenoid in the shutter assembly operates to remove the polyiron core. The input signal passes through the input waveguide section, the directional coupler, DC-501, the input attenuator AT505, to the AFC mixer. At low power levels, some signal will go through the TR tube, V501, to the modulator mixer. R-501 is a resistance card termination for the nominal 30-db directional coupler.

1-27. The afc mixer is used to mix the input microwave signal with the radar local oscillator output to produce the 40-mc signal. Incorporated in the E-plane arm of the afc mixer is a variable r-f attenuator, AT-505, which has a nominal insertion of

0 to 65 db. This variable attenuator is used to reduce the input power to the afc mixer when the Range Calibrator is used with high-power input signals. The signal sample from the directional coupler passes through the 0 to 65 db attenuator and into the E-plane arm of the afc mixer. The radar local oscillator output is introduced into the H-plane arm of the afc mixer. Two crystal diodes, CR-504 and CR-505, are mounted in the symmetrical arms of the afc mixer. CR-504 is a 1N23C crystal while CR-505 is a 1N23CR reversed polarity crystal. The mixing action in the afc mixer between the input microwave signal and the local oscillator output is such that the resultant 40-mc signals are fed from CR-504 and CR-505 to the afc chassis through coaxial cables connected to J-504 and J-505.

1-28. The radar local oscillator mount is used to mount the radar local oscillator tube, V-503, a 2K25. The input d-c power to the radar local oscillator is furnished through a cable which is connected to J-205, the Radar AFC Chassis. The radar local oscillator output power is fed into the H-plane arm of a modified magic-T mixer. The attenuator, AT-504, is a variable 0- to 20-db attenuator which is controlled from the front panel. This control is used to set the injection level of the radar local oscillator power to the modified magic-T. This magic-T splits the power between the afc mixer and the modulator-mixer assemblies. R-503 is a resistance card termination in the E-plane arm of the modified magic-T.

1-29. The radar-beacon switch, E-502, is a mechanical assembly which switches the local oscillator output power to the modulator-mixer. This switch is mechanically linked to the RADAR - BEACON switch, S-104 (12, figure 4-1), on the front panel. It contains a vane which is loaded with polyiron. When the switch is in the RADAR position, the radar local oscillator power from V-503 is fed into the H-plane arm of the modulator mixer. When the switch is in the BEACON position, a load is presented to the radar local oscillator and the output of the beacon local oscillator, V-502, is fed to the modulator-mixer.

1-30. MODULATOR-MIXER. The modulator-mixer is used to convert the delayed 40-mc signals to microwave signals at either the beacon or radar frequency. It is a magic-T mixer assembly with either radar or beacon local oscillator power fed into the H-plane arm of the mixer from the radar-beacon switch, E-502. The delayed 40-mc signals are impressed on the signal modulator crystal, CR-502, a 1N23C. The mixing action is such that the resultant sideband-frequency signals are transmitted out through the E-plane arm of the magic-T, through the TR-tube, and to the output flange of the R-F Assembly. In the other symmetrical arm of the T is the external modulation crystal, CR-501, a 1N23C. This crystal is connected to the external modulation jack, J-108 (4, figure 4-1), on the front panel and is used in conjunction with an external 40-mc pulse to produce a one-way target signal as outlined in paragraph 4-22.

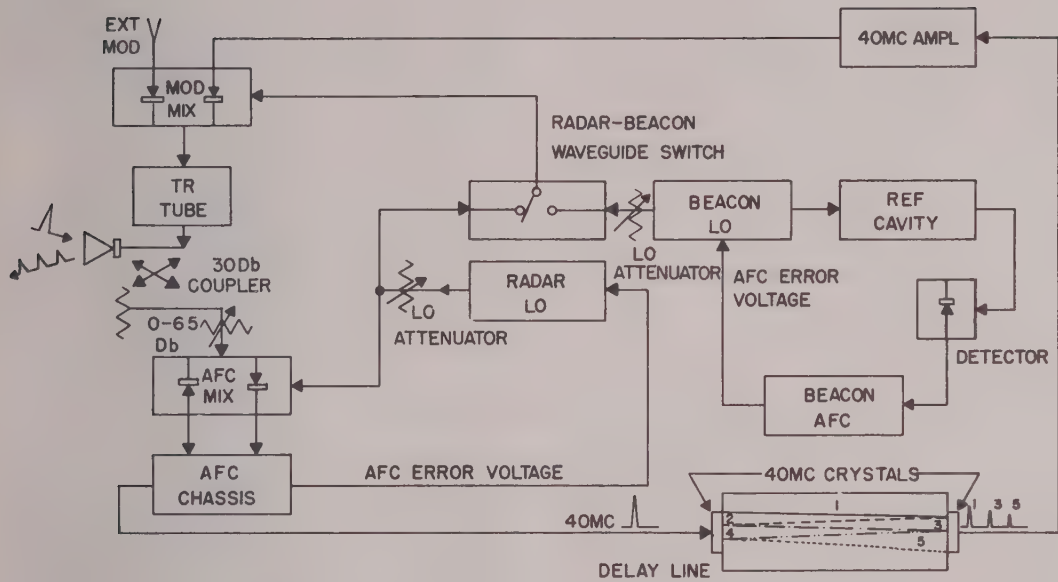


Figure 1-4. General Block Diagram of Range Calibrator

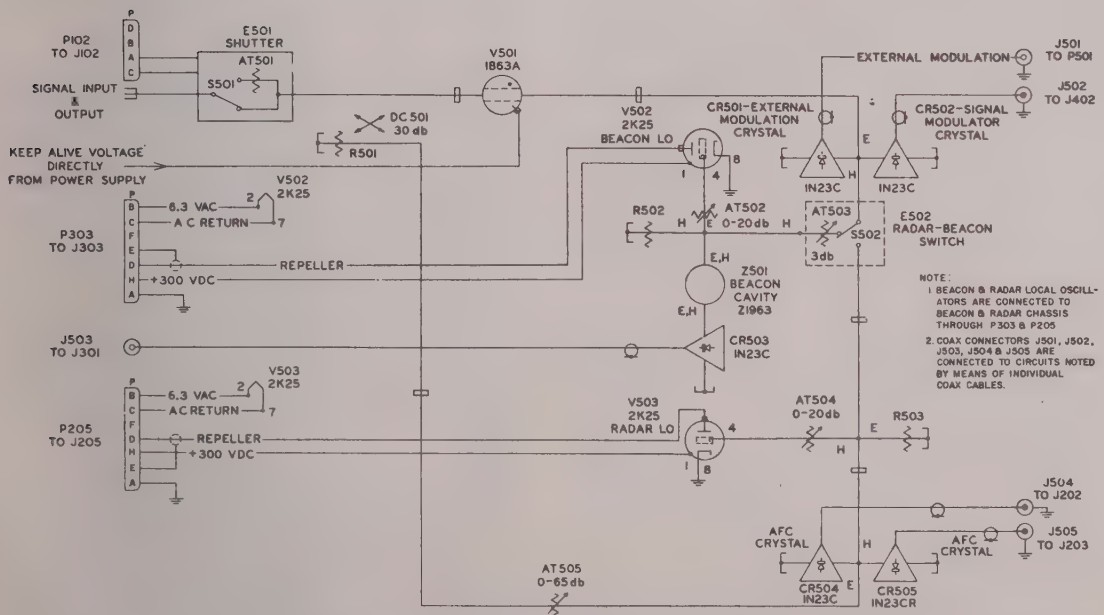


Figure 1-5. Schematic Diagram of R-F Assembly

1-31. The beacon local oscillator mount is used to mount the beacon local oscillator tube, V-502, a 2K25. D-c power for the local oscillator tube is obtained through a cable which is connected to J-303 on the Beacon AFC Chassis. The output of the beacon local oscillator tube is controlled by attenuator, AT-502, a nominal 0- to 20-db attenuator. This attenuator is adjusted internally in the Range Calibrator as outlined in paragraph 5-24. The output of the beacon local oscillator is split in a modified magic-T mixer, part of it going to the radar-beacon switch, and the other part going to the beacon reference cavity, Z-501. The beacon reference cavity is a high-Q cavity tuned to 9350 mc. The output of the cavity goes to the crystal detector, CR-503, a 1N23C crystal. The output of this crystal detector is fed to J-301 on the Beacon AFC Chassis.

1-32. RADAR AFC CHASSIS, figure 1-6.

1-33. The Radar AFC Chassis is used to maintain the frequency of the radar local oscillator tube 40 mc lower than the input radar signal and to furnish the 40-mc pulse to the ultrasonic delay line. The radar afc is a phantastron sweep type. It consists of two 40-mc i-f amplifiers, a discriminator, a phantastron sweep tube, a stopper tube, an agc tube, a video amplifier, a video limiter and a cathode-follower driver stage for the delay line.

1-34. The 40-mc output pulses from CR-504 and CR-505 in the R-F Assembly are connected to the Radar AFC Chassis through J-202 and J-203. The terminating resistors for the crystals are the series resistor pairs, R-244 plus R-205 and R-245 plus R-206. The crystal-current metering leads are connected to the midpoint of these resistor pairs. L-201 with C-205 and L-202 with C-207 are the filter circuits for metering. The 40-mc pulses are coupled through C-204 and C-206 to the grids of V-202, the first pulse amplifier stage, and V-201, the cathode-follower driver. L-203, L-204 and R-207 form a broad-band degenerate pi network in the grid of V-202. V-201 is a conventionally designed broad-band cathode-follower which is used as a low-impedance driver for the ultrasonic delay line. The output of the cathode-follower is connected to J-201.

1-35. V-202 and V-203 are conventional i-f amplifier stages which amplify the 40-mc pulses and feed them into the discriminator. The circuitry following V-203 and including V-204 is a Weiss discriminator. L-207 is a tuneable coil used to adjust the crossover frequency of the discriminator to 40 mc, while L-205 is used to balance the discriminator output. The output S-curve of the discriminator can be observed at TP-202. The separation of the discriminator S-curve peaks is approximately 3.25 mc. The low-frequency peak is positive-going while the high-frequency peak is negative-going.

1-36. An automatic gain control circuit is used to prevent overload of the i-f amplifier stages. The negative-going voltage at TP-201 is applied through

C-220 to the automatic gain control amplifier section of V-208. C-221 couples the amplified signal to the grid of the second section of V-208 which operates at fixed bias. When the amplified agc signal is large enough to overcome this fixed bias, a voltage is developed across C-222. This voltage is filtered by R-224 and C-223 and is fed to the grids of the i-f amplifier tubes, V-202 and V-203. It is monitored at TP-203.

1-37. The output of the discriminator is fed to the video amplifier stage, V-205. This stage is a direct-coupled inverse-feedback-pair video amplifier, in which the output of the first triode section is directly coupled to the input of the second triode section. This amplifier has a high gain at low signal levels and a low gain at high signal levels. The amplified video signals from this stage are coupled through C-226 to the input grid of one section of V-206. This stage is a limiting amplifier with a high cathode-bias which limits the amplitude of the positive signal to the d-c voltage drop across R-230.

1-38. The second section of V-206 is used as the stopper tube. A positive signal from the discriminator, after amplification in V-205 and the limiting amplifier section of V-206, results in a negative-going signal at the plate of the positive-limiting section of V-206. This negative signal is coupled through C-228 to the cathode of the second section of V-206, the stopper tube. Through the action of the stopper tube C-229 is charged negatively. This negative charge is filtered by R-234 and C-230 and applied as a bias voltage to the input grid of V-207, the phantastron.

1-39. The action of the phantastron depends upon the negative transconductance which exists between the screen grid and the suppressor grid of a pentode tube. It operates as a free-running sawtooth oscillator. The plate voltage sweeps slowly from just below the plate supply voltage to a point not far from the cathode voltage, after which it snaps back rapidly and starts the downsweep again. The grid-plate time constant is such that the sweep rate is approximately two cycles per second. This sawtooth sweep voltage is applied to the reflector control of the radar local oscillator, causing the radar local oscillator to sweep. The total frequency excursion swept through by the radar local oscillator is approximately 60 mc. The REFLECTOR control, R-118 (8, figure 4-1), on the front panel is used to set the level about which the radar local oscillator sweeps.

1-40. The bias voltage from the stopper tube, V-206, effectively lowers the transconductance of the phantastron, V-207, to a point where it stops sweeping. The phantastron tube then acts as a d-c amplifier to hold the reflector voltage of the radar klystron to the d-c level for maintaining the correct frequency of the radar local oscillator. The reflector voltage is monitored at TP-204. C-232 and R-246 are to improve the closed-loop stability.

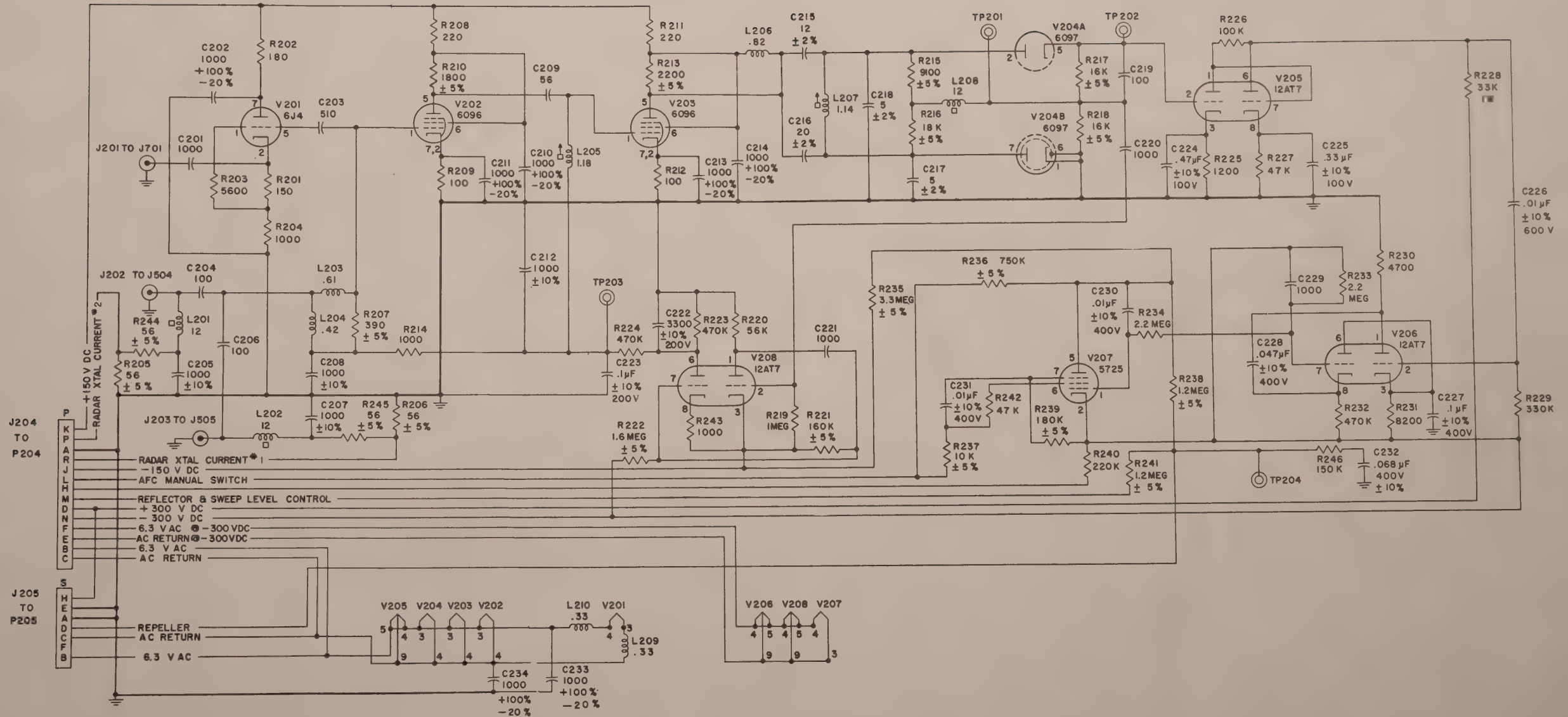


Figure 1-6. Schematic Diagram of Radar AFC Chassis

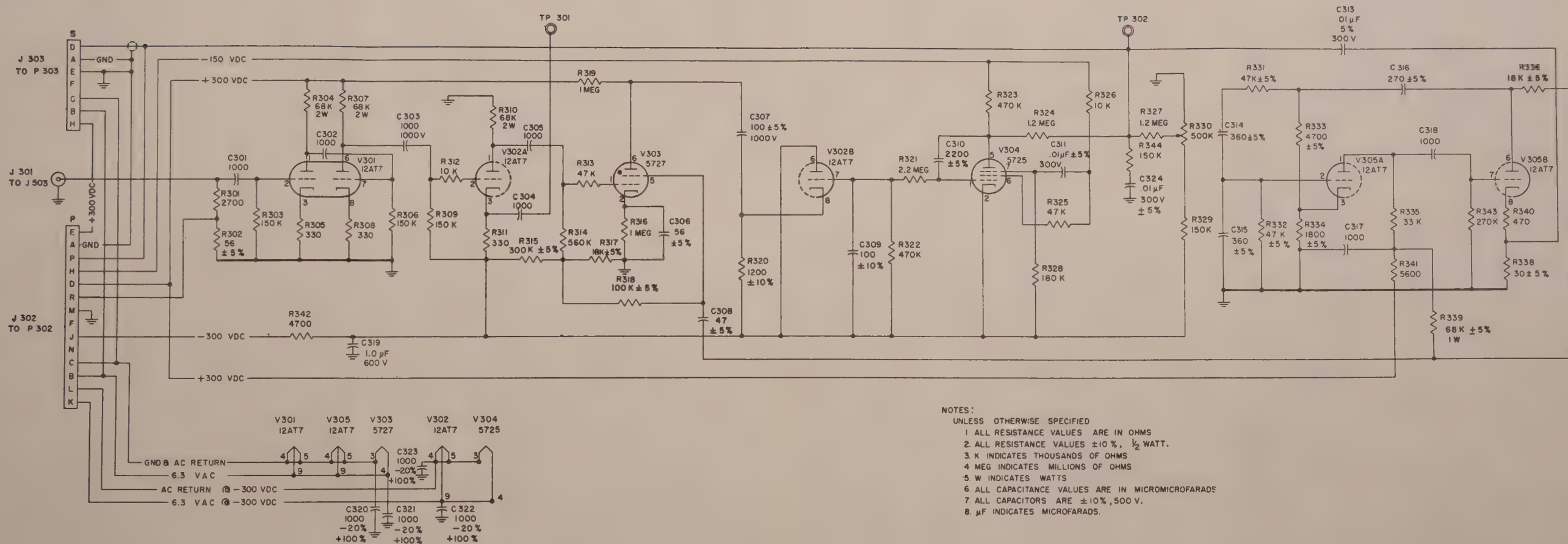


Figure 1-7. Schematic Diagram of Beacon AFC Chassis

1-41. When the radar AFC - MANUAL switch, S-103 (9, figure 4-1), on the front panel is in the MANUAL position the screen of the phantastron, V-207, is connected to -300-volts dc to prevent sweeping. At the same time the d-c level at the plate of V-207 is set to its average sweep level by the bleeder network, R-236 and R-235. This allows the same control, R-118, to be used in both MANUAL and AFC functions to set the repeller voltage of the radar local oscillator.

1-42. DELAY LINE AND OVEN ASSEMBLY, figure 1-9. The output 40-mc pulse from J-201 on the Radar AFC Chassis is connected to the input terminal, J-701, on the Delay Line and Oven Assembly through coaxial cable. The oven assembly maintains the temperature of the ultrasonic delay line at a temperature of 71°C (160°F) to avoid change in the delay line characteristics as the equipment ambient temperature is varied.

1-43. The temperature of the oven is controlled by the thermostat assembly, Z-701, which is bypassed by C-701. Input (115 volts) is connected to E-701 and E-702. L-701 and L-702 form tuned circuits with the capacity of the input and output cables.

1-44. The ultrasonic delay line is a hermetically-sealed unit containing a quartz delay bar with piezo-electric crystals attached to each end. These crystals serve as transducers to effect the conversion from electrical energy to ultrasonic energy. The delay of the line depends on the length of the quartz bar.

1-45. The input 40-mc pulse excites the transducer on the input end causing the crystal to oscillate at an ultrasonic frequency. This generates ultrasonic waves which are propagated through the quartz delay bar. At the other end of the quartz delay bar, these ultrasonic waves are converted to a 40-mc pulse by the transducer crystal. This first pulse is delayed in time by the delay of the line.

1-46. A portion of the ultrasonic energy is reflected within the delay line back to the input transducer where reflection again occurs. This reflected energy is converted to a second 40-mc pulse by the transducer at the output end of the delay line. This second pulse is separated from the first pulse by approximately twice the delay of the line. This process of reflection occurs repeatedly. The output of the delay line is thus a series of pulses, each pulse appearing at approximately the odd numbered intervals of the delay line delay. The pulse-to-pulse separation is approximately twice the delay of the line. The delay line losses cause each consecutive pulse to be reduced in amplitude. This output train of pulses at J-702 is connected by coaxial cable to J-401 on the 40-Mc Amplifier Chassis.

1-47. 40-Mc AMPLIFIER CHASSIS, figure 1-8. The 40-Mc Amplifier Chassis is used to amplify the output pulses of the delay line and to provide the modu-

lating pulse to the signal modulator crystal. It consists of three pentode i-f amplifier stages, V-401, 402 and 403 and a dual-triode, V-404, used as a grounded-grid amplifier to drive a cathode-follower output stage.

1-48. The over-all configuration of the broad-band i-f amplifier is a staggered-triple design followed by a broad-band stage with cathode-follower output. V-401, V-402 and V-403 are tuned to 38.8, 40 and 41.2 mc respectively. V-404A is tuned to 40 mc. L-406 is a tuneable coil to obtain the optimum over-all bandpass of the amplifier. V-404B is a cathode-follower stage used to drive the signal modulator crystal, CR-502, in the R-F Assembly. The signal crystal current is metered at the midpoint of R-414 and R-415. The Crystal-current filtering circuit is made up of L-408, C-417 and C-418. The series of amplified output pulses is connected from J-402 to J-502 in the R-F Assembly by coaxial cable. When the I F. SIG. switch, S-105 (13, figure 4-1), is in the OFF position, the +150 volts is removed from the 40-mc amplifier, thereby eliminating the return-echo pulses.

1-49. BEACON AFC CHASSIS, figure 1-7. The Beacon AFC Chassis maintains the frequency of the beacon local oscillator, V-503, at 9350 mc. It is an absolute-frequency type of afc in that the frequency of the local oscillator is locked to the frequency of the beacon reference cavity, Z-501 in the R-F Assembly. A phantastron type sweep circuit and a 10-kc coincidence detector are used to control the reflector voltage of the local oscillator. The circuitry includes a phantastron, a stopper tube, a 10-kc oscillator, three stages of 10-kc amplification and a thyatron coincidence stage.

1-50. The phantastron is composed of V-304 and associated circuitry. Its action is similar to the action of the phantastron in the radar afc. The negative-going sawtooth output of the phantastron is applied to the reflector control of the beacon local oscillator tube. The sweep frequency is approximately 13 cps and the total sweep excursion of the local oscillator is approximately 50 mc. The d-c level of the reflector is set by R-330 (3, figure 1-3). The setting of R-330 is made from the top of the Beacon AFC Chassis. The beacon local oscillator voltage is monitored at TP-302.

1-51. Superimposed on this sweep voltage is a small 10-kc signal. This signal is taken from the cathode of V-305B and coupled through C-313. V-305A and B is a Wien Bridge oscillator operating at 10 kc. A 10-kc reference voltage is taken from the plate of V-305B and fed to grid No. 2 of V-303, the coincidence tube. The combination of C-308 and R-318 is a phase-shift network to correct for the phase difference between the currents in the plate resistance, R-336, and the cathode resistances, R-340 and R-338.

1-52. This modulated sweep voltage is applied to the reflector of the beacon local oscillator tube, V-503,

in the R-F Assembly. The resultant frequency-modulated r-f output of the local oscillator is fed through the high-Q reference cavity to the crystal detector, CR-503. By slope detection in the cavity, the f-m output of the local oscillator is converted to a-m microwave power. The phase of the 10-kc modulation reverses as the frequency of the local oscillator passes through the cavity resonant frequency. When the local-oscillator frequency is higher than the cavity frequency, the 10-kc modulation is in phase with the cavity output.

1-53. This 10-kc modulation is detected in CR-503, and applied to V-301 in the Beacon AFC Chassis. Beacon crystal current is monitored at the junction of R-301 and R-302. Both sections of V-301 and the first section of V-302 are used to amplify the 10-kc signal. Over-all gain of these three stages at 10-kc is approximately 20,000. The amplified 10-kc signal is coupled into the grid of the coincidence tube, V-303. The 10-kc error signal is monitored at TP-301.

1-54. The coincidence tube is used to compare the phase of the amplified 10-kc voltage and the 10-kc reference voltage. When these two voltages are in phase, the tube conducts, and discharges C-307 through R-320, C-319 and C-306. R-317 and R-315 are used to apply a bias to V-303 to prevent its firing while C-307 is being charged through R-320 and R-319. C-306 and R-316 develops the cathode bias to aid in extinguishing the thyratron between pulses.

1-55. The voltage developed across R-320 by the discharge of C-307 is rectified by V-302B, and applied to C-309 and R-322. It is filtered by R-321 and C-310 and applied as a bias voltage to stop the sweep action of the phantatron, V-304. The phantatron then acts as a d-c amplifier to control the d-c level of the reflector of the beacon local oscillator.

1-56. POWER SUPPLY CHASSIS, figure 1-11. The Power Supply Chassis furnishes all voltages necessary to operate the Range Calibrator. The Range Calibrator can be connected to any 115-volt, a-c, single-phase, 50- to 800 cps source.

1-57. The power connection is made by the power cord, CX-1490/U, to connector J-101. Both sides of the input line are fused with five-ampere fuses, F-101 and F-102. When input switch S-101 is in the OFF position, the a-c power is applied to the standby heater, in the fan-deck assembly, HR-601, and in the ON position, the a-c power is disconnected from the heater, HR-601, and applied to the primary of the power transformer, T-101, and fan-deck thermostat, S-601. The plate winding of the power transformer, T-101, is connected to rectifiers V-101, V-102 and the selenium rectifier, CR-101.

1-58. Tube V-101 and its associated filter is a conventional full-wave rectifier. The output of the filter

is applied to the voltage regulator, which regulates the +300-volts d-c output. The voltage regulator uses V-103, with both halves of the tube connected in parallel, as the series resistance tube. V-104 is the regulator amplifier and amplifies the changes in voltage at the output of the supply. Its reference voltage is furnished by the voltage regulator tube, V-105. The +300-volts d-c output is adjusted to the proper level by the potentiometer, R-113.

1-59. The +150-volt d-c supply, used by the radar a-fc circuitry and the 40-mc amplifier, is developed through a series dropping resistor, R-115, from the regulated +300-volt d-c supply. When the L F. SIG. switch, S-105, is in the OFF position, R-127 is connected from +150 volts to ground. Thus it replaces the 40-mc amplifier load and keeps the supply nominally at +150 volts.

1-60. Tube V-102 and its associated filter is a conventional half-wave rectifier power supply, but serves a dual purpose. It supplies the -300-volts d-c supply, and in conjunction with the selenium rectifier, CR-101 in the voltage-doubling circuit, also furnishes the -900-volt d-c supply for the keep-alive voltage required to ionize the TR-tube, V-501. Two VR-tubes, V-106 and V-107, connected in series with R-106 as the series resistance, regulate the -300-volt d-c supply. The -150-volts dc is obtained from a point between V-106 and V-107. R-108 and C-107 provide filtering for the -900-volt d-c supply. Power transformer, T-101, has three 6.3-volt filament windings. One winding, 13-14, is biased at -300-volts, to supply filaments in the Beacon AFC and Radar AFC.

1-61. The METER SELECTOR switch, S-102, connects the 500-microampere meter, M-101, to the various circuits. With this switch, +150-volts dc, +300-volts dc, TR-tube voltage, -300-volts dc, signal crystal current, radar a-fc crystal No. 1, radar a-fc crystal No. 2, and beacon crystal currents can be measured.

1-62. FAN DECK ASSEMBLY, figure 1-10. With switch, S-101, in the OFF position and with the power cord connected, power is applied to the standby heater, HR-601. The purpose of this heater is to allow the calibrator to remain on standby and to keep the unit dry. With switch, S-101, in the ON position, whenever the cabinet temperature reaches 26.6°C (80°F), the thermostat, S-601, closes and connects the power to the fan motor, B-601. This reduces the cabinet temperature. If the temperature inside the cabinet drops below 4.5°C (40°F), the thermostat opens and disconnects the fan motor.

CAUTION

Fan motor runs hot. Do not touch.

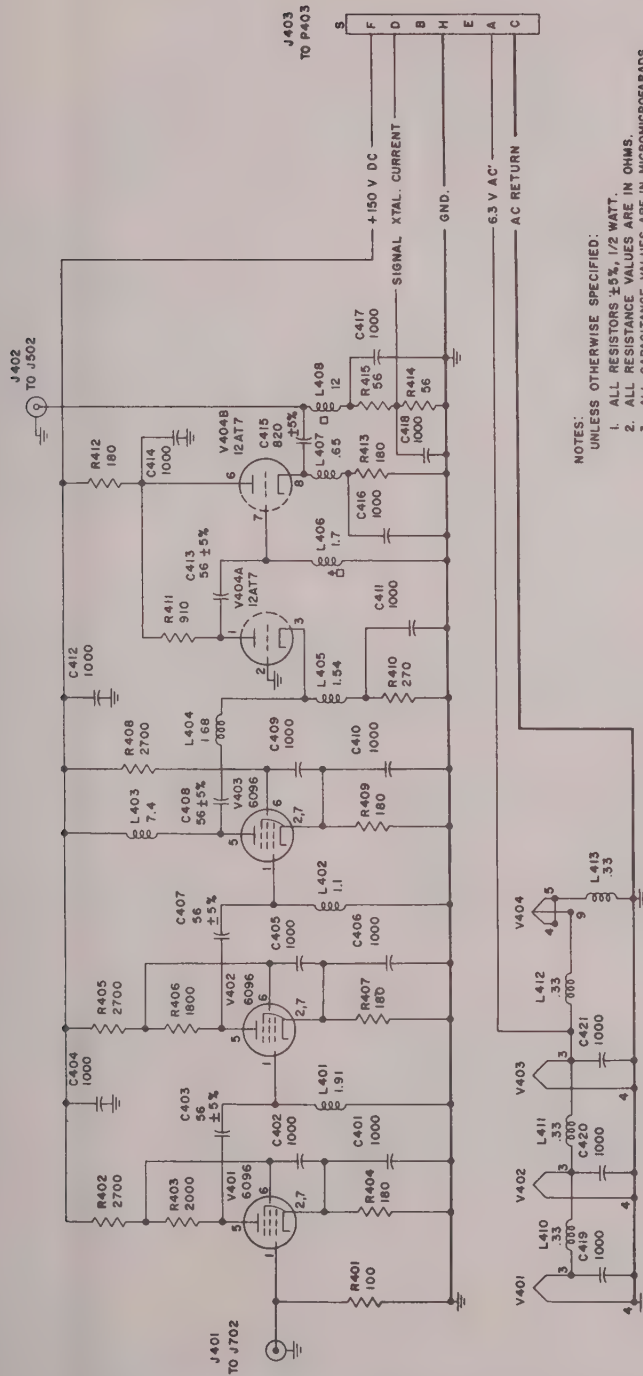


Figure 1-8. Schematic Diagram of 40-Mc Amplifier Chassis

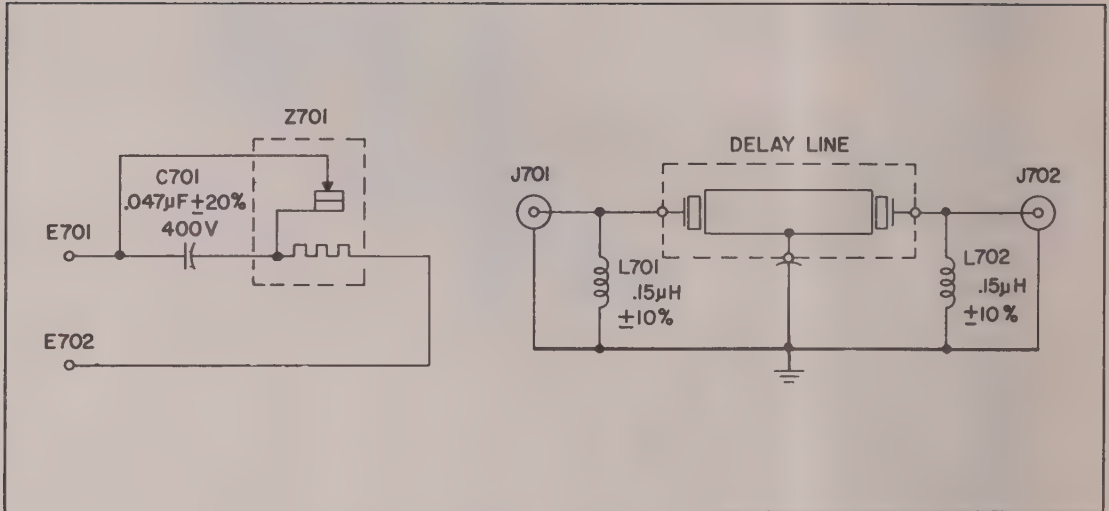


Figure 1-9. Schematic Diagram of Delay Line and Oven Assembly

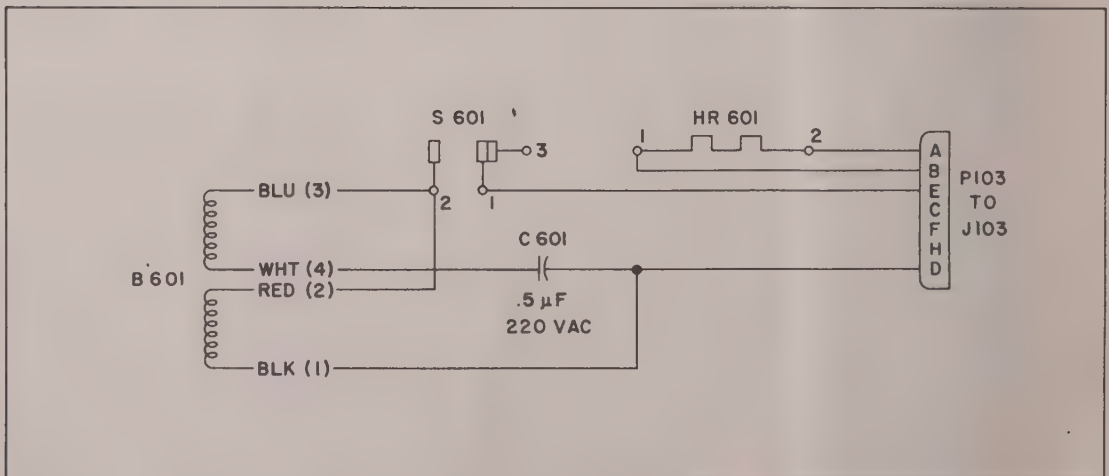
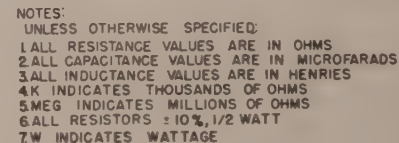


Figure 1-10. Schematic Diagram of Fan Deck Assembly



Revised 1 September 1954

TABLE I
ACCESSORY EQUIPMENT

Description	Figure and Index No.	Quantity
Antenna Horn FAR-801268-1	1-2; 14	1
Waveguide Fitting UG-591/U	5	1
Waveguide Fitting UG-592/U	6	1
Waveguide Assembly CG-673/ U	9	1
Clamp UG-590/U	17	2
Power Cable Assembly CX-1490/U	2	1
Cord FAR-702169G1	7	1
Measuring Tape TL-598/U	4	1
Wrench 4260-102-103	15	1
Wrench 4260-104-103	15	1
Wrench 4260-103-103	15	1
Lamp 600093-5	16	2
Fuse FO3G5ROOA	16	10
Storage for Spare Delay Line	8	

SECTION II

TEST EQUIPMENT AND SPECIAL SERVICE TOOLS

2-1. There are no special service tools required to operate the Range Calibrator Set AN/UPM-11A. Special test equipment is used for checks and measure-

ments made in checking and maintenance procedures. (See Section VII)

SECTION III

PREPARATION FOR USE

3-1. The Range Calibrator Set AN/UPM-11A is completely assembled and calibrated before packing and requires no installation of parts or adjustments.

3-2. The Range Calibrator Set AN/UPM-11A should be checked for operation as outlined in paragraph 4-12.

3-3. The power required to operate the Range Calibrator Set AN/UPM-11A is approximately 250 watts at 115-volts ac, single phase, 50 to 800 cps. The Range Calibrator may be operated either in or out of the transit case, or it may be mounted for rack installation in the laboratory. The bench space required is approximately 2 feet by 3 feet.

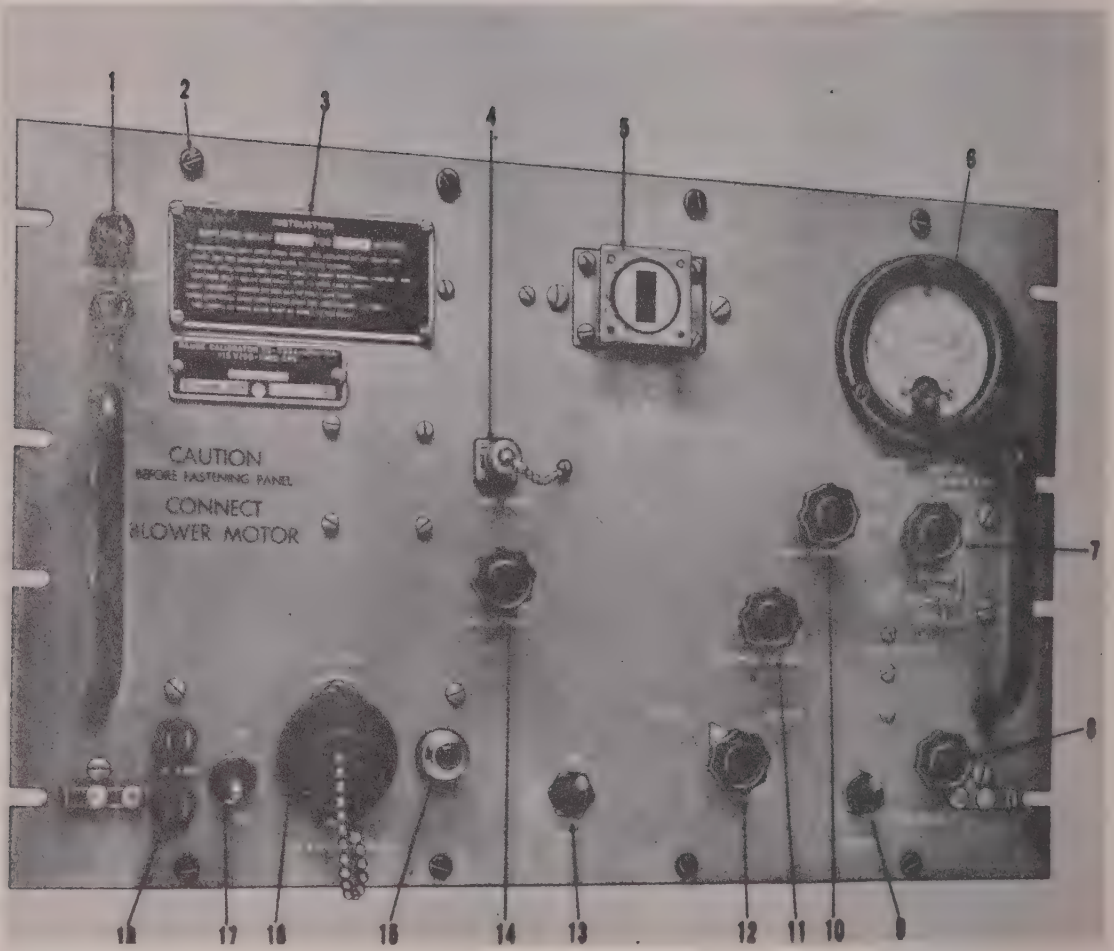


Figure 4-1. Front Panel of Range Calibrator

KEY

- | | | |
|-----------------------------|-------------------------|-------------------------|
| 1. Fuse Holder | 7. Meter Selector | 13. I. F. Signal Switch |
| 2. Captive Screw | 8. Reflector | 14. L. O. Attenuator |
| 3. Instruction Plate | 9. AFC-Manual Switch | 15. Indicator Lamp |
| 4. External Modulation Jack | 10. Input Attenuator | 16. Power Receptacle |
| 5. Waveguide Connection | 11. L. O. Coarse Tuning | 17. ON-OFF Switch |
| 6. Meter | 12. Radar-Beacon Switch | 18. Fuses |

SECTION IV

OPERATION

4-1. GENERAL.

4-2. This section contains the operating instructions for the Range Calibrator Set AN/UPM-11A.

4-3. The Range Calibrator may be used either with the antenna horn, FAR-801268-1 (14, figure 1-2), or with the cord, FAR-702169G1 (7, figure 1-2). The operating procedure is the same. The difference lies in the preliminary procedure and method of interpretation of results obtained.

4-4. PRELIMINARY PROCEDURE AND CONNECTIONS.

4-5. The equipment may be operated either in or out of the transit case, FAR-900714-1 (1, figure 1-2). It may also be rack-mounted for laboratory use.

4-6. The power cable assembly, CX-1490/U (2, figure 1-2), should be removed from the transit case and connected to the input power receptacle (16, figure 4-1) on the front panel. The other end of the cord should be connected to a 115-volt, 50 to 800-cps, single-phase power source.

4-7. The Range Calibrator may be either directly coupled to the radar directional coupler or it may be positioned at a distance from the radar set and the antenna horn used to couple into the radar.

4-8. If the Range Calibrator is to be directly coupled to the radar, the following procedure should be used:

a. Connect waveguide adapter, UG-591/U (5, figure 1-2), to the r-f waveguide output flange (5, figure 4-1), on the Range Calibrator.

b. Connect one end of the cord, FAR-702169G1, to the adaptor, UG-591/U.

c. Connect the other end of the cord, FAR-702169G1, to the directional coupler of the radar set.

d. The delay of the cord, FAR-702169G1, is approximately four yards. This delay must be added to the delay of the first pulse as outlined in paragraph 4-28. If additional r-f cable is used, the delay of this cable must also be added to the delay of the first pulse.

4-9. If the Range Calibrator is to be positioned at a distance from the radar, the following procedure should be used:

a. Connect the antenna horn, FAR-801268-1 (14, figure 1-2), to the r-f waveguide output flange (5, figure 4-1), on the Range Calibrator. The antenna horn as mounted on the Range Calibrator is

horizontally polarized. If vertical polarization is desired, the waveguide assembly, CG-673/U (9, figure 1-2), should be used between the antenna horn and the Range Calibrator.

b. The Range Calibrator should be positioned so that the antenna horn is pointed at the radar antenna.

c. The distance between the radar antenna and the Range Calibrator should be measured using measuring tape TL-598/U (4, figure 1-2). This distance should be added to the delay of the first pulse as outlined in paragraph 4-29.

d. It is also possible to connect the antenna horn, FAR-801268-1, to the cord, FAR-702169G1. The cord should be connected to the Range Calibrator using adapter UG-591/U (5, figure 1-2), and to the antenna horn using adapter UG-592/U (6, figure 1-2). In this setup, the delay of the cord plus the distance from the radar antenna to the antenna horn must be added to the delay of the first pulse.

4-10. PURPOSE AND USE OF OPERATING CONTROLS.

4-11. Figure 4-1 shows the operating controls, meter and connectors.

4-12. STARTING PROCEDURE AND WARM-UP.

4-13. Turn the power switch, S-101 (17, figure 4-1), to the ON position. The indicator lamp (15, figure 4-1), should light. For maximum accuracy the equipment should be allowed to warm up for 20 minutes. At ambient temperatures below -30°C (-22°F), warm-up time should be 30 minutes. This warm-up time is required to stabilize the temperature of the ultrasonic delay line.

4-14. RANGE CALIBRATOR CHECK-OUT.

4-15. The METER SELECTOR switch (7, figure 4-1), should be used to check the power supply voltages. The +300-volt supply should be within 5 volts of the nominal value. R-113 is used to adjust this voltage. The control is located in the lower left hand corner of the power-supply chassis. The other voltages are not critical and should be within 10 volts of the nominal value. The TR voltage should be within 50 volts of the nominal -900 volts. This completes the voltage check-out.

WARNING

Voltages in excess of 125 volts occur within the test set. Use extreme caution when servicing or repairing. The highest voltage is the -900-volt TR-tube voltage.

4-16. To check the circuitry of the Range Calibrator the following procedure should be used:

a. Place the controls in the following positions:

1. METER SELECTOR (7, figure 4-1): SIG. XTAL.

2. L. O. COARSE TUNING (11, figure 4-1): Rotate approximately 2 turns from full clockwise position.

3. L. O. ATTEN (14, figure 4-1): Rotate approximately 4 turns from full clockwise position.

4. REFLECTOR (8, figure 4-1): Rotate to full counterclockwise position.

5. I. F. SIG (13, figure 4-1): ON.

6. RADAR - BEACON (12, figure 4-1): RADAR.

7. A. F. C. - MANUAL (9, figure 4-1): MANUAL.

b. Adjust REFLECTOR control to obtain peak reading of the signal crystal current on meter. The reading should be constant. Set level of crystal current to approximately 0.6 ma on meter by adjusting the L. O. ATTEN. control. Clockwise rotation of this control increases signal crystal current.

c. Turn METER SELECTOR control to RADAR A. F. C. XTAL 1 and RADAR A. F. C. XTAL 2. The meter reading of these crystals may be higher or lower than the signal crystal reading. The difference of the readings of the two afc crystals should not be greater than 0.3 ma. This checks the operation of the radar local oscillator and the crystals.

d. Operate the A. F. C. - MANUAL switch to A. F. C. The meter should sweep at approximately a two-cycle-per-second rate when the METER SELECTOR control is switched to SIG. XTAL, RADAR A. F. C. XTAL 1, and RADAR A. F. C. XTAL 2. This checks the action of the radar afc sweep circuits.

e. Operate the RADAR - BEACON switch to BEACON. Read beacon crystal current on the meter. The reading should be between 0.15 ma and 0.5 ma and should be constant. Read signal crystal current on the meter. This should be constant and approximately 0.6 ma. This checks the action of the beacon afc circuitry and the beacon local oscillator.

f. This completes the check-out of the circuitry of the Range Calibrator.

4-17. RADAR CALIBRATION.

4-18. To check the ranging circuits of the radar, it is necessary to lock-on the Range Calibrator to the radar. This is accomplished by manually tuning the frequency of the radar local oscillator in the Range Calibrator. The indication of lock-on is given when the radar local oscillator stops sweeping as shown

by a steady value of radar afc crystal current read on the meter of the Range Calibrator. At this time, the target echoes appear on the radar indicator.

4-19. To lock-on the Range Calibrator to the radar, the following procedure should be used:

a. Place the controls in the following positions:

1. METER SELECTOR (7, figure 4-1): Either RADAR A. F. C. XTAL 1 or RADAR A. F. C. XTAL 2.

2. RADAR - BEACON (12, figure 4-1): RADAR.

3. A. F. C. - MANUAL (9, figure 4-1): A. F. C.

4. I. F. SIG (12, figure 4-1): ON.

b. Rotate the L. O. COARSE TUNING control full clockwise.

c. Adjust the REFLECTOR control to keep the afc crystal current sweeping. It is possible at some settings of the L. O. COARSE TUNING control to obtain peaks of crystal current at two different settings of the REFLECTOR control. The position which is most counterclockwise should be used.

d. Adjust the L. O. ATTEN. control so that the afc crystal current sweeps about 0.6 ma as an average value.

e. With the radar transmitter operating, slowly turn the L. O. COARSE TUNING control counterclockwise, maintaining the maximum swing of the meter by adjusting the REFLECTOR control.

f. Lock-on is indicated when the meter pointer stops sweeping and indicates a constant value of crystal current. Slowly turn the L. O. COARSE TUNING control counterclockwise for maximum afc crystal current.

g. To check for correct afc lock-on, turn the MANUAL - A. F. C. switch to MANUAL. Leaving the L. O. COARSE TUNING control set, adjust the REFLECTOR control to obtain maximum afc crystal current. Then turn the MANUAL - A. F. C. switch back to A. F. C. The afc crystal current should be approximately the same when the switch is operated between the A. F. C. and MANUAL positions. This indicates proper lock-on. If the values of the afc crystal current differ radically in switching from A. F. C. to MANUAL, steps b. through f. above should be repeated, taking care that the REFLECTOR control is set at the most counterclockwise point to give peak crystal current.

h. When lock-on has been achieved, place the METER SELECTOR switch in the SIG. XTAL position. Adjust the L. O. ATTEN. control so that the signal crystal current is approximately 0.6 ma. This completes radar lock-on. Return-echo signals fed back to the radar under calibration are at the same frequency as the radar.

4-20. BEACON OPERATION.

4-21. For checking the beacon circuitry of the radar, it is necessary that the Range Calibrator be locked-on to the radar as outlined above. When lock-on has been accomplished, the RADAR - BEACON switch (12, figure 4-1) is placed in the BEACON position. When the radar set is switched to beacon operation, the return-echo pulses will appear on the radar indicator.

4-22. EXTERNAL MODULATION.

4-23. It may sometimes be desirable to add external modulation to the output pulses of the Range Calibrator. External sine wave or noise modulation may be injected into the Range Calibrator through the EXT. MOD. jack, J-108 (4, figure 4-1), on the front panel. This modulation is impressed across the external modulation crystal, CR-501, in the R-F Assembly. This crystal is terminated in 110 ohms (R-129) at the front panel.

4-24. It is also possible to use the Range Calibrator as a one-way single-pulse echo. This may be accomplished as follows:

a. The Range Calibrator should be locked-on to the radar.

b. The I. F. SIG. switch (13, figure 4-1), should be placed in the OFF position. This eliminates the echo pulses fed back to the radar from the ultrasonic delay line.

c. An external pulsed 40-mc oscillator should be connected to the EXT. MOD. jack, J-108, on the front panel. Maximum input voltage should be approximately 10 volts peak.

d. A single echo pulse should appear on the radar. It may be necessary to place the MANUAL - A. F. C. switch (9, figure 4-1), in the MANUAL position and adjust the REFLECTOR control (8, figure 4-1), slightly before the echo pulse appears.

4-25. INTERPRETATION OF RESULTS.

4-26. With the Range Calibrator locked-on to the radar, the return-echo pulses appear as artificial targets on the radar scope or other ranging devices. This allows calibration and adjustment of the radar circuitry.

4-27. The range scale of the radar scope should be set to approximately ten times the nominal delay of the delay line. The nominal delay of the line is marked on the delay line and also on the small metal plate on top of the delay line oven.

4-28. If the cord FAR-702169G1 (7, figure 1-2), is used to connect the Range Calibrator to the radar, the first return pulse will appear at a range delay which is the sum of the delay line delay marked on

the delay line, the range calibrator delay marked on the front panel plate of the calibrator, and the delay of the cord FAR-702169G1. The propagation constant of the cord is 1.5, so that the effective delay of the cord is 1.5 times its length, or 12 feet. Thus the cord delay is four yards.

4-29. If the antenna horn, FAR-801268-1 (14, figure 1-2), is used, the first return pulse will appear at a range delay which is the sum of the delay line delay, the range calibrator delay, and the distance from the radar antenna to the Range Calibrator as measured using tape, TL-598/U (4, figure 1-2).

4-30. The range delay between the first return pulse and the second return pulse or between any two subsequent return pulses will be two times the delay line delay as marked on the delay line. The range calibrator delay, the delay of the cord, or the separation distance between the radar and the Range Calibrator are not to be added to the range delay between pulses. These delays are included in the range delay of the first pulse only.

4-31. BORESIGHTING.

4-32. The Range Calibrator can be used as a target in boresighting to replace a corner reflector. The antenna horn, FAR-801268-1, should be connected to the Range Calibrator and placed at least 30 feet ahead of the radar antenna. The antenna horn should be placed as high above the ground as possible to prevent ground reflections from causing faulty radar operation. The minimum height should be such that the angle formed by a line from the radar antenna to the range calibrator antenna horn and the radar antenna to the ground should be at least twice the width of the radar antenna or the antenna horn, whichever is greater. The antenna horn has a beam width of 20 degrees.

4-33. STOPPING THE EQUIPMENT.

4-34. The Range Calibrator may be placed in standby condition by turning the power switch (17, figure 4-1) to the OFF position and leaving the power cord (2, figure 1-2) connected to the primary power source. This removes voltage from the set and applies voltage to the heater strip in the fan-deck assembly, thus maintaining the Range Calibrator at a temperature above ambient.

4-35. To remove the Range Calibrator from service, the following procedure should be used:

a. Turn the power switch (17, figure 4-1) to the OFF position.

b. Disconnect power cable assembly, CX-1490/U (2, figure 1-2).

c. Remove antenna horn or cord connectors from Range Calibrator.

d. Replace all accessories in the lid of transit case, FAR-900714-1 (1, figure 1-2).

e. Place Range Calibrator in the U-shaped mount-

ing bracket in the transit case. Secure the equipment by tightening the knurled nuts on the swivel toggle bolts (11, figure 1-2).

f. Secure the lid with clamps (10, figure 1-2).

SECTION V

INSPECTION AND PREVENTIVE MAINTENANCE

5-1. INSPECTION.

5-2. A periodic inspection of the Range Calibrator as outlined in TABLE III should be made at approximately six-month intervals. This check should be made regardless of whether the Range Calibrator is in daily use or in temporary storage. If the equipment is sealed for storage, the inspection should be postponed until the time that it is placed in service. The inspection area should be clean and dust free. The frequency and scope of periodic inspection may be altered by local authorities as usage or conditions may dictate.

5-3. The Range Calibrator has been designed for optimum serviceability. The following paragraphs describe the operations necessary to gain access to the various chassis and component parts for inspection and maintenance.

5-4. RANGE CALIBRATOR CHASSIS.

5-5. To gain access to the Range Calibrator Chassis, the instrument cover should be removed. This is accomplished by unfastening the eight captive screws (2, figure 4-1), four each on top and bottom of the front panel. The instrument case can then be slid off the front panel and the Range Calibrator Chassis, separating them approximately three inches. The power cord to the fan-deck assembly should then be disconnected at J-103, after which the instrument case can be completely removed. This gives complete access to the Range Calibrator Chassis.

5-6. RADAR AFC, BEACON AFC, AND 40-MC AMPLIFIER CHASSIS.

5-7. The Radar AFC, the Beacon AFC and the 40-Mc Amplifier Chassis may be inspected by removing the shield cans attached to the bottoms of the chassis. Each shield can be removed by removing the bottom screws securing it to the chassis posts. For more extensive inspection and/or maintenance, each of these three chassis may be removed completely from the Range Calibrator Chassis by removing the four corner screws at the top of the chassis. It will, of course, be necessary to disconnect all cabling to the chassis prior to its removal from the Range Calibrator Chassis.

5-8. POWER SUPPLY AND FRONT PANEL CHASSIS

5-9. The removal of the power supply chassis from the Range Calibrator Chassis is a major operation and should not be attempted in the field. All components are readily accessible for maintenance and inspection without removing it from the Range Calibrator Chassis.

5-10. OVEN AND DELAY LINE ASSEMBLY.

5-11. The delay line assembly is a hermetically-sealed unit and should not be tampered with. It is removable from the oven by unscrewing the top knurled ring on the oven and removing the oven end cap, thus exposing the delay line. To remove the oven, the following procedure should be used:

a. Disconnect coaxial cables from oven at J-702 on the top and J-701 on the bottom.

b. Disconnect oven heater at E-701 and E-702 on the bottom of oven.

c. Remove the four screws holding oven to front panel.

d. Remove oven.

5-12. R-F ASSEMBLY.

5-13. In case it becomes necessary to remove the R-F Assembly, the following procedure should be used:

a. Disconnect all coaxial cables to the crystal mounts.

b. Disconnect the two klystron power input cables.

c. Disconnect the shutter power cable at J-102 on the power supply.

d. Disconnect the flexible drive shafts connected to the attenuator and the cavity tuning shaft of the radar local oscillator tube, V-503.

e. Disconnect the connecting link between the RADAR - BEACON switch (12, figure 4-1), S-104, and the waveguide switch in the R-F Assembly.

f. Remove the lead to the TR-tube, V-501.

g. Remove the four screws that connect the R-F Assembly to the Range Calibrator Chassis. These are accessible at the bottom of the Range Calibrator Chassis.

h. Remove the input waveguide flange on the front panel by removing four screws.

i. Remove the two large screws that bolt the waveguide to the front panel.

j. Remove the R-F Assembly from the Range Calibrator Chassis.

CAUTION

In replacing the R-F Assembly, care should be taken to align the slot of the 0- to 65-db attenuator in the radar afc mixer arm with the control shaft on the front panel. This can be accomplished by pulling the knob on the control shaft slightly away from the panel, rotating the knob till the offset on the shaft is aligned with the slot in the attenuator, then releasing knob.

5-14. REMOVAL OF CRYSTALS IN THE R-F ASSEMBLY.

5-15. Caution should be exercised when changing the

crystals in the R-F Assembly to prevent breakage. The following procedure should be used:

a. Using a screwdriver, loosen the inner plug of the crystal holder approximately one-half turn.

b. Unscrew the outside shell of the crystal holder from the crystal mount socket.

c. Remove the inner plug from the shell which allows the crystal to be withdrawn.

d. In reinstalling crystals, the reverse procedure is to be followed: that is, the crystal holder shell should be tightened in the crystal holder socket, then the inner plug should be tightened. Excessive torque or pressure should not be used in changing crystals.

e. CR-505 should always be replaced with a 1N23CR, reversed polarity crystal.

5-16. BEACON CRYSTAL.

5-17. The beacon crystal CR-503 is removed by disconnecting the coaxial cable at J-503 and unscrewing the crystal cap assembly from the crystal mount. The crystal is held in the cap by spring tension.

5-18. LUBRICATION.

5-19. No lubrication of parts is required for the Range Calibrator Set AN/UPM-11A.

TABLE III

PERIODIC INSPECTION AND PREVENTIVE MAINTENANCE

Component	Inspection
Tubes	Remove and check on a dynamic mutual-conductance vacuum-tube tester. Replace all doubtful tubes and those that do not meet required specification. Replace all satisfactory tubes in tube socket.
Crystals	Remove and check for conversion loss. Replace all crystals having greater than 6 db conversion loss. See Paragraph 5-14 for procedure in removing crystals.
Connectors	Check for bent pins, dirt, corrosion or pitting of contacts. Replace defective parts.
Switches	Check switch operation, both mechanically and electrically. Check continuity of circuitry through switches. Replace defective parts.
Wiring	Examine wiring for obvious breaks and shorts. Visually inspect wiring insulation for evidence of breakdown, shorts or fraying.
Fuses	Check for continuity. Replace defective parts.
Lamps	Check for continuity.
Oven	Check continuity of heater between E-701 and E-702. Resistance should be approximately 250 ohms. Check for continuity between input jacks J-701 and J-702, and internal contact.

TABLE III (Continued)

Component	Inspection
Fan Motor	Check for proper operation. Motor should rotate counterclockwise as viewed from fan end at approximate speed of 3000 rpm at 60 cps.
Heater Strip	Check continuity and measure cold resistance. Value should be approximately 130 ohms.
Chassis	Check for dirt and corrosion.
Front Panel	Check for proper operation of all controls. Repaint bare or chipped places. Check legibility of panel markings.
Spares	Check spares box in transit case and replace all missing lamps and fuses.
Miscellaneous	Check all nuts, bolts and screws for tightness. Check all cables, waveguide connections and tube clamps for tightness.

5-20. TROUBLE SHOOTING.

5-21. Many failures and malfunctions of the Range Calibrator may be traced to relatively simple causes such as blown fuses, faulty vacuum tubes, broken wires or faulty connections. The relatively simple sources of possible trouble should always be checked first. All trouble shooting should proceed in a systematic fashion, starting with the power input source. The electrical schematic diagrams, figures 1-5 to 1-11 should be used in making continuity checks while TABLES IV through VIII should be used for checking the nominal resistance and voltages at the various tube sockets.

NOTE

Except where noted, all voltage measurements in TABLES IV through VIII are made from tube socket pin to ground at an input voltage at 115 volts, 60 cycles. The RADAR - BEACON switch (12, figure 4-1) should be in the BEACON position, the A. F. C. - MANUAL switch (9, figure 4-1) in the MANUAL position, and the I. F. SIG. switch (13, figure 4-1) in the ON position. All resistance measurements are made from tube socket pin to ground. All values are nominal, and actual voltages and resistances measured on a particular unit may vary from these values. A vacuum tube voltmeter should be used for voltage measurement.

CAUTION

Voltages in excess of 125 volts exist within the Range Calibrator. The highest voltage is the nominal -900-volt TR-tube voltage. Use extreme caution in circuit checking and trouble shooting. The metal shell of the klystron tubes, V-502 and V-503, in the R-F Assembly are operated at +300 volts.

5-22. The preliminary electrical checkout as given in paragraph 4-14 through 4-16 will serve as a basis for proper trouble shooting in a systematic fashion. Detail trouble shooting recommendations are given at the end of this section.

5-23. ALIGNMENT OF BEACON AFC.

5-24. In case the beacon afc local oscillator tube V-502 is replaced, the beacon afc circuitry will have to be realigned. The following procedure should be used:

- Place RADAR - BEACON switch (12, figure 4-1) in BEACON POSITION.
- Place METER SELECTOR switch (7, figure 4-1) in SIG. XTAL position.
- Allow equipment to warm up for approximately 10 minutes.
- Adjust R-330 (3, figure 1-3) on top of BEACON AFC Chassis so that voltage measured at TP-302 on beacon chassis is approximately -150 volts.
- Adjust mechanical cavity tuning on beacon local oscillator V-502 until signal crystal current stops sweeping and slowly adjust for peak crystal current.
- Loosen two small screws on bottom of beacon local oscillator mount and adjust position of attenuator, AT-502, until signal crystal current reads approximately 0.6 ma.
- Disconnect cable at J-301 on Beacon AFC Chassis.
- Signal crystal current will start to sweep.
- Adjust R-330 on Beacon AFC Chassis for maximum signal crystal current while sweeping.

j. Reconnect cable at J-301. Signal crystal current should have a steady value of approximately 0.6 ma.

k. Place METER SELECTOR switch in BEACON

XTAL position. A steady value of current should be read. This value of current should be greater than 0.15 ma and less than 0.5 ma.

l. This completes the beacon afc alignment.

Radar AFC-Manual

XV201

Pin No.	Voltage	Resistance
1	+10 DC	6.6 K
2	+11 DC	1.15 K
3	0	0
4	6.3 AC	0
5	+9 DC	6.5 K
6	+9 DC	6.5 K
7	+139 DC	230 K

XV202

Pin No.	Voltage	Resistance
1	-.4 DC	940 K
2	+1.45 DC	100 ohms
3	6.3 AC	0
4	0	0
5	+117 DC	232 K
6	+135 DC	230 K
7	+1.45 DC	100 ohms

XV203

Pin No.	Voltage	Resistance
1	+.4 DC	940 K
2	+1.5 DC	100 ohms
3	6.3 AC	0
4	0	0
5	+135 DC	232 K
6	+135 DC	230 K
7	+1.5 DC	100 ohms

XV204

Pin No.	Voltage	Resistance
1	0	0
2	-.45 DC	25 K
3	6.3 AC	0
4	0	0
5	-.06 DC	32 K
6	0	0
7	-.45 DC	25 K

XV205

Pin No.	Voltage	Resistance
1	+86 DC	363 K
2	-.06 DC	32 K
3	+1.4 DC	1.2 K
4	6.3 AC	0
5	6.3 AC	0
6	+202 DC	263 K
7	+86 DC	363 K
8	+87 DC	47 K
9	0	0

XV206

Pin No.	Voltage	Resistance
1	-4 DC	4.7 K
2	-300 DC	405 K
3	-292 DC	83 K
4	-300 DC	75 K
5	-300 DC	75 K
6	-292 DC	83 K
7	-300 DC	2.5 Meg
8	-299 DC	540 K
9	-300 DC	75 K
4-9	6.3 AC	
5-9	6.3 AC	

XV207

Pin No.	Voltage	Resistance
1	-300 DC	5 Meg
2	-300 DC	75 K
3	-300 DC	75 K
4	-300 DC	75 K
5	-230 DC	540 K
6	-300 DC	130 K
7	-300 DC	260 K
3-4	6.3 AC	

XV208

Pin No.	Voltage	Resistance
1	-90 DC	56 K
2	-150 DC	1.1 Meg
3	-150 DC	50 K
4	-300 DC	75 K
5	-300 DC	75 K
6	-.4 DC	470 K
7	-160 DC	195 K
8	-150 DC	50 K
9	-300 DC	75 K
4-9	6.3 AC	
5-9	6.3 AC	

TABLE V

I. F. Amplifier

XV401

Pin No.	Voltage	Resistance
1	0	0
2	+1.7 DC	180 ohms
3	6.3 AC	0
4	0	0
5	93 DC	235 K
6	113 DC	233 K
7	+1.7 DC	180 ohms

XV402

Pin No.	Voltage	Resistance
1	0	.1 ohms
2	+1.7 DC	180 ohms
3	6.3 AC	0
4	0	0
5	+95 DC	234 K
6	+113 DC	233 K
7	+1.7 DC	180 ohms

XV403

Pin No.	Voltage	Resistance
1	0	.1
2	+2.12 DC	180 ohms
3	6.3 AC	0
4	0	0
5	+140 DC	230 K
6	+113 DC	233 K
7	+2.12 DC	180 ohms

XV404

Pin No.	Voltage	Resistance
1	+130 DC	231 K
2	0	0
3	+1.37 DC	270 ohms
4	0	0
5	0	0
6	+138 DC	230 K
7	0	0
8	+1.15 DC	180 ohms
9	6.3 AC	0

TABLE VI

Power Supply

XV101

Pin No.	Voltage	Resistance
1	0	∞
2	+460 DC	1.02 Meg
3	0	∞
4	450 AC	38 ohms
5	0	∞
6	450 AC	40 ohms
7	0	∞
8	+460 DC	1.02 Meg
2-8	5.0 AC	

XV102

Pin No.	Voltage	Resistance
1	0	∞
2	450 AC	40 ohms
3	0	∞
4	-550 DC	84 K
5	0	∞
6	-550 DC	84 K
7	0	∞
8	450 AC	40 ohms
2-8	5.0 AC	

XV103

Pin No.	Voltage	Resistance
1	+235 DC	1.5 Meg
2	+440 DC	1.02 Meg
3	+300 DC	230 K
4	+235 DC	1.5 Meg
5	+440 DC	1.12 Meg
6	+300 DC	230 K
7	+150 DC	240 K
8	+150 DC	240 K
7-8	6.3 AC	

XV104

Pin No.	Voltage	Resistance
1	+149 DC	108 K
2	+150 DC	240 K
3	+150 DC	240 K
4	+150 DC	240 K
5	+235 DC	1.6 Meg
6	+180 DC	510 K
7	+150 DC	240 K
3-4	6.3 AC	

XV105

Pin No.	Voltage	Resistance
1	+150 DC	240 K
2	0	0
3	+.02 DC	∞
4	0	0
5	+150 DC	240 K
6	+.01 DC	∞
7	0	0

XV106

Pin No.	Voltage	Resistance
1	0	0
2	-150 DC	50 K
3	-.01 DC	∞
4	-150 DC	50 K
5	0	0
6	-.05 DC	∞
7	-150 DC	50 K

XV107

Pin No.	Voltage	Resistance
1	-150 DC	50 K
2	-300 DC	75 K
3	-76 DC	∞
4	-300 DC	75 K
5	-150 DC	50 K
6	-85 DC	∞
7	-300 DC	75 K

TABLE VII

Beacon AFC

XV301

Pin No.	Voltage	Resistance
1	+94 DC	300 K
2	0	150 K
3	+1.05 DC	330 ohms
4	0	0
5	0	0
6	+94 DC	300 K
7	0	150 K
8	+1.05 DC	330 ohms
9	6.3 AC	0

XV302

Pin No.	Voltage	Resistance
1	-190 DC	68 K
2	-283 DC	240 K
3	-282 DC	85 K
4	-300 DC	75 K
5	-300 DC	75 K
6	-283 DC	85 K
7	-285 DC	118 K
8	-283 DC	76 K
9	-300 DC	75 K
4-9	6.3 AC	
5-9	6.3 AC	

XV303

Pin No.	Voltage	Resistance
1	-16.9 DC	625 K
2	+19 DC	1 Meg
3	0	0
4	6.3 AC	0
5	-5 DC	118 K
6	+220 DC	1.3 Meg
7	-5 DC	118 K

XV304

Pin No.	Voltage	Resistance
1	-286 DC	2.7 Meg
2	-275 DC	75 K
3	-300 DC	75 K
4	-300 DC	75 K
5	-205 DC	450 K
6	-153 DC	103 K
7	-275 DC	265 K
3-4	6.3 AC	

XV305

Pin No.	Voltage	Resistance
1	+213 DC	266 K
2	0	47 K
3	+3.6 DC	1.8 K
4	0	0
5	0	0
6	+142 DC	265 K
7	+2.75 DC	270 K
8	+1.82 DC	503 ohms
9	6.3 AC	0

TABLE VIII

R. F. Head

XV502

Pin No.	Voltage	Resistance
1	+300 DC	230 K
2	6.3 AC	0
3		
4		
5		
6		
7	0	0
8	0	0
CAP	-110 to -190 DC Nom. -155 AC	CAP 670 K to 730 K

XV503

Pin No.	Voltage	Resistance
1	+300 DC	230 K
2	6.3 AC	0
3		
4		
5		
6		
7	0	0
8	0	0
CAP	-110 to -190 DC	CAP 670 K to 750 K

TROUBLE SHOOTING

Trouble	Probable Cause	Remedy
Power switch in ON position, pilot lamp does not light	No power input	Check power source, power cable, and connector J-101
	Burnt out pilot lamp	Check and replace I-101
	Blown fuses	Check fuses F-101 and F-102
	Bad power switch	Check and replace S-101
	Transformer primary open	Check for continuity between terminals 1 and 2 of T-101
	Transformer filament open	Check continuity between terminals 7 and 8 of T-101
	Faulty socket	Check for voltage at inner socket terminals with lamp removed
No indication on meter in any position	Defective meter	Check connections from meter M-101 to switch S-102
	Defective switch	Check continuity at all points on switch S-102

TROUBLE SHOOTING (Continued)

Trouble	Probable Cause	Remedy
No meter reading in any voltage position	Open transformer secondary	Check for continuity between terminals 4, 5, and 6 on T-101
	Open wiring	Check continuity of wiring to switch S-102
No meter reading on +300V position or +150V position	Defective tubes	Check tubes in following order: V-101, V-103, V-104 and V-105. Replace bad tubes
	Open filament winding	Check for continuity between terminals 9 and 10 and between terminals 15 and 16 on T-101
	Open wiring	Check continuity of wiring to switch S-102
Meter read on +300V position but no reading on +150V position	Open resistor	Measure resistance of R-115 in power supply. Value should be 2000 ohms
	Open wiring	Check continuity between R-112 and R-115 in power supply. Also check continuity of wiring to switch S-102 from R-115
High or low voltage reading on +300V position	Pot set wrong	Adjust R-113 in power supply so that meter reads 300 ± 5 volts
	Resistor value change	Measure resistance of R-102. Value should be $510 K \pm 10\%$
Meter reading on +300V and +150V positions but no meter reading on -300V or TR-V positions	Defective tube	Check V-102 and replace if necessary
	Open filament	Check continuity between terminals 11 and 12 on T-101
	Open wiring	Check continuity of wiring to switch S-102
Meter reading on -300V position is high, approximately -500 volts	Defective tube	Check V-106 and V-107. Replace if necessary
Meter reading on -300V position is low, approximately -250 volts	Open solenoid	Check for continuity through solenoid in shutter assembly in R-F Assembly. Also, check to see if solenoid is connected to power supply at J-102
Meter reading on -300V position but no reading on TR-V position	Defective rectifier	Check CR-101. Replace if necessary
	Open resistor	Check value of R-126. Value should be approximately 27 K. Check value of R-111. Should be $500 K \pm 1\%$. Also check value of R-130. Should be $250 K \pm 1\%$
	Shorted condenser	Check C-101 and replace if necessary
No meter reading on crystal positions	Defective crystals	Check and replace crystals. Refer to paragraph 5-15 for replacement procedure
	Open crystal terminating resistors	Check values of the appropriate resistors which are located in the various chassis
	Defective klystrons	Check V-502 and V-503 in R-F Assembly. Replace if necessary. Caution: The shell on the klystron is operated at +300 volts.

TROUBLE SHOOTING (Continued)

Trouble	Probable Cause	Remedy
Meter reading of SIG. XTAL sweeps in BEACON position	Beacon afc not locked on	Refer to paragraph 5-23 for proper setup procedure
Range Calibrator locks on to radar, but no return echo signals noted on radar scope	I. F. SIG. switch in OFF position	I. F. SIG. switch, S-105, should be in ON position
	Defective crystal	Check CR-502 and replace if conversion loss is more than 6 db
	Defective tubes	Check all tubes in 40-mc amplifier. Replace weak or defective tubes
	Defective delay line	Replace delay line
	Defective cabling	Check the following coaxial cables: Radar afc to oven, oven to 40-mc amplifier, and 40-mc amplifier to CR-502
	Faulty radar	Check radar receiver gain, radar receiver afc and radar indicator
Return echo signals on radar scope with Range Calibrator in RADAR position, but no return echo signals with Range Calibrator in BEACON position	Faulty radar	Radar must be in beacon function. Check beacon afc circuits in radar and beacon receiver gain

SECTION VI

PREPARATION FOR RESHIPMENT

6-1. PREPARATION FOR RESHIPMENT.

6-2. To prepare the Range Calibrator Set AN/UPM-11A for reshipment, the following procedure should be used:

a. Clean the Range Calibrator Set AN/UPM-11A of all dirt and dust, using an air hose.

b. Install the Range Calibrator in the transit case. Lock it securely to the shock mount rack in the transit case.

c. Check that all accessories, including spares, are contained within the lid of the transit case.

d. Securely close the transit case and wrap in grade A paper.

e. Pack the transit case in a corrugated carton of sufficient size to allow for cushioning and the packing of several bags of Silica Gel dessicant.

f. Place the corrugated carton in a moisture-proof vapor-barrier bag, exhaust the air from the vapor-barrier bag and heat seal.

g. Place the equipment in a water-proof corrugated carton and seal.

SECTION VII

RANGE CALIBRATOR SET
RECEIVER DELAY CALIBRATION

7-1. **PURPOSE.** The purpose of the Receiver Calibration procedure is to check the delay of the Range Calibrator Set and to insure proper operation of the Range Calibrator Set. If the Range Calibrator Set is malfunctioning, see Trouble Shooting, Section V. The Range Calibrator Set (UPM-11A) should be checked at each 6 month interval.

7-2. **TEST EQUIPMENT REQUIRED.**

- a. RF Pulse Generator, FEC 801384.
- b. X-Band Receiver, FEC 900956-A.
- c. X-Band Receiver Power Supply, FEC 702722.
- d. Standard Delay Line.
- e. VTVM, RCA Volt-ohmmist Junior.
- f. VTVM, HP-400C.
- g. Ammeter, 0-50 Microampere.
- h. Cavity, PRD 559-B.
- i. Oscilloscope, Tektronics 514 AD.
- j. Slide Screw Tuner, PRD No. 303A.
- k. Constant Voltage Transformer, Sola Catalog No. 3004.
- l. Miscellaneous Waveguide Sections, T's, Loads, and Coaxial Cables.

7-3. **PROCEDURE.**

- a. Place a Range Calibrator Set in the test position.
- b. Remove Range Calibrator instrument cover as follows:
 1. Unfasten the eight captive screws, four each on top and bottom, on the front panel of the Range Calibrator.
 2. Slide front panel forward about three inches from instrument case.
 3. Disconnect power cord from fan-deck assembly at J-103.
 4. Remove instrument case from the Range Calibrator chassis.
- c. Remove cap from top of oven and remove the delay line from the oven. Insert standard delay line in the oven and replace oven cap.

d. Remove rubber receptacle cap from the Range Calibrator.

e. Insert polarized AC socket into the Range Calibrator power receptacle and plug into the 115 VAC, 60-800 cps, power outlet.

f. Set the Range Calibrator ON-OFF switch to the ON position.

g. Turn METER SELECTOR switch to the "-300" position.

h. Meter shall read 300 immediately after the shutter solenoid is activated (clicks).

i. Set RF Pulse Generator OUTPUT ATTEN control to the "100" position.

j. Set the X-Band Receiver, RF Pulse Generator, and Oscilloscope power switches to the ON position.

k. After one minute, set X-Band Receiver B+ switch to the ON position.

l. Allow equipment and Range Calibrator a forty-five minute warm-up period.

m. Turn METER SELECTOR switch on Range Calibrator to the "+300" position.

n. If meter does not read 300 ± 5 volts, perform the following.

1. Loosen lock-nut on potentiometer (R-113).

2. Adjust R-113 on Range Calibrator for a reading of 300 on Range Calibrator meter.

3. Tighten lock-nut on potentiometer (R-113).

o. Turn METER SELECTOR switch on Range Calibrator to the "+150" position. Meter should read 150 ± 10 volts.

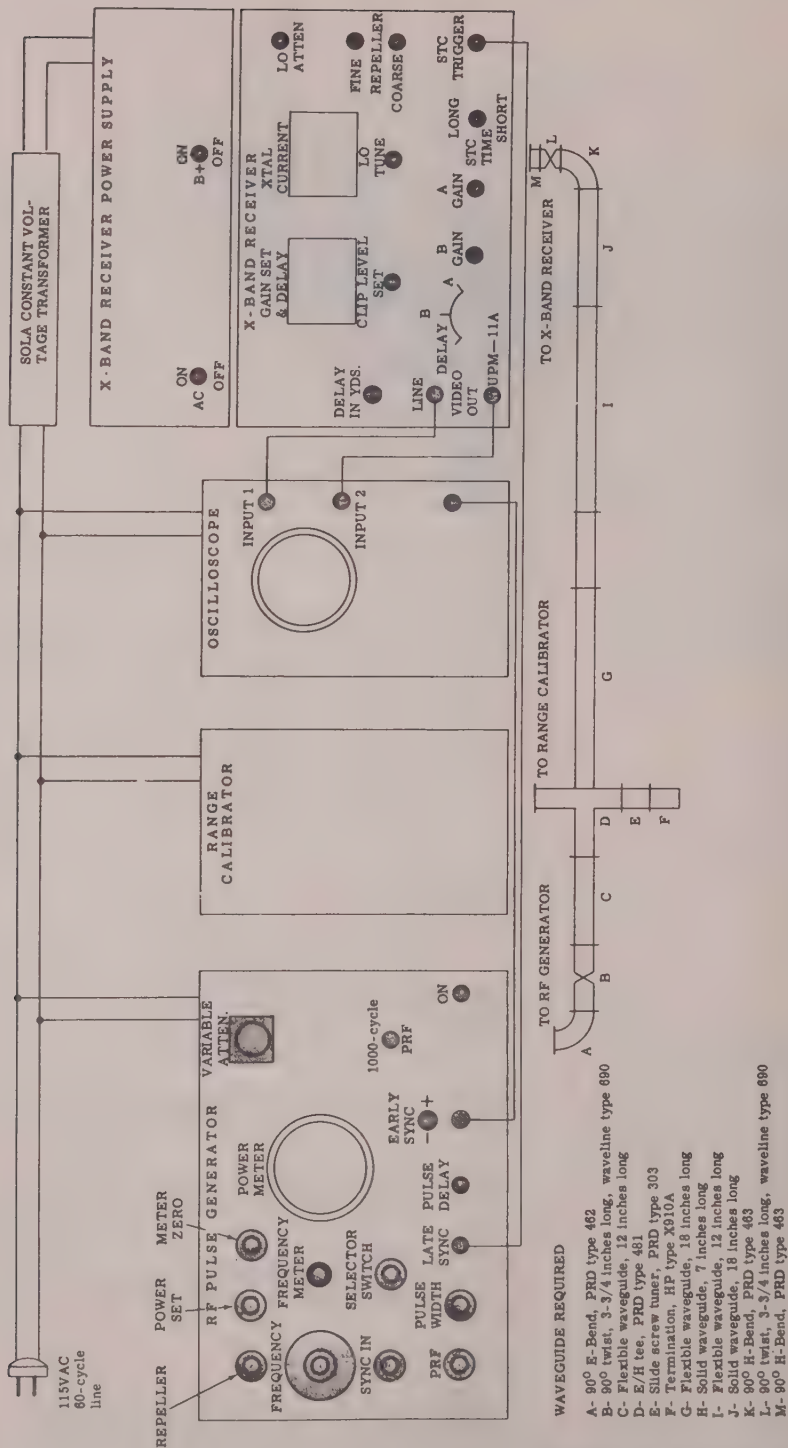
p. Turn METER SELECTOR switch on Range Calibrator to the TR-V position. Meter should read 900 ± 50 volts.

q. Set METER SELECTOR switch on Range Calibrator to the "-300" position. Meter should read 300 ± 10 volts.

7-4. **BEACON LOCK-ON.**

a. Set the Range Calibrator controls as follows:

1. Turn METER SELECTOR to the SIG-XTAL position.



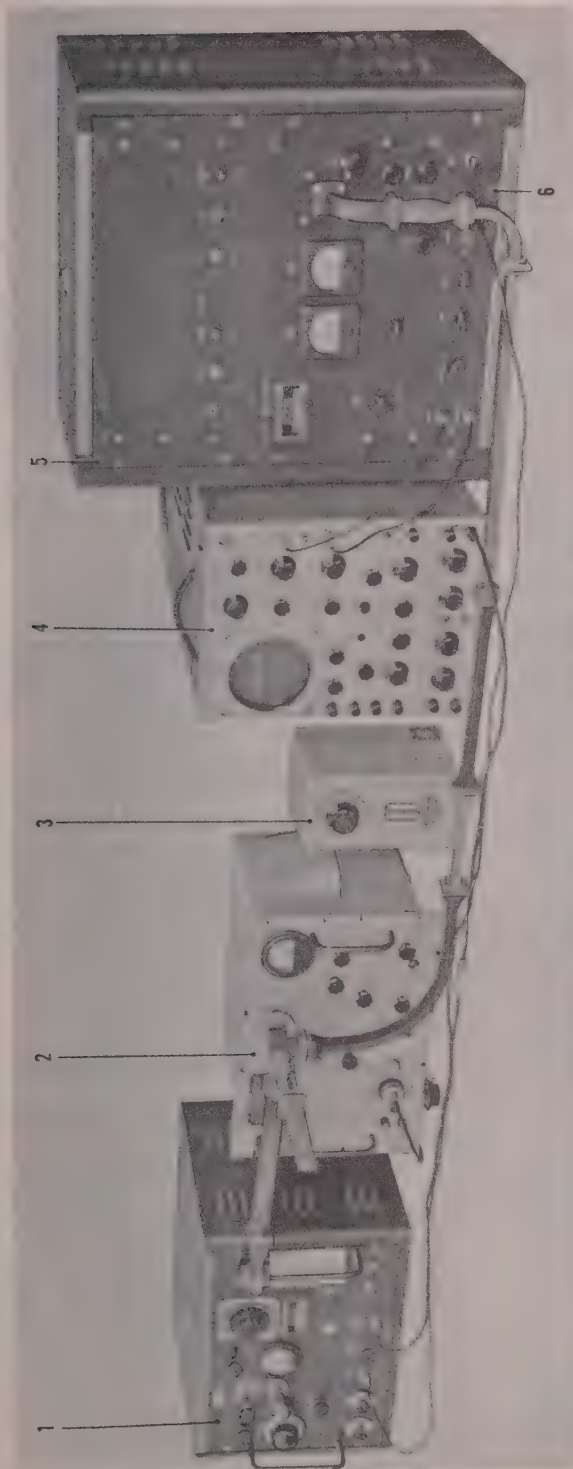


Figure 7-2. Test Setup, Major Components

- | | |
|-----------------------|--------------------------|
| 1. RF pulse generator | 4. Oscilloscope |
| 2. Range calibrator | 5. Receiver power supply |
| 3. Precision cavity | 6. X-Band receiver |

2. Set BEACON-RADAR switch to the BEACON position.

3. Set IF SIG switch to the ON position.

4. Turn INPUT ATTEN to the maximum clockwise position.

5. Turn LO ATTEN to the maximum counterclockwise position.

b. A crystal current reading shall be indicated on the Range Calibrator meter.

c. If a crystal current reading is not indicated, proceed as directed in Section V, paragraph number 5-23 (Alignment of Beacon AFC).

7-5. RIPPLE.

a. Set the MANUAL-AFC switch on the Range Calibrator to the MANUAL position.

b. Set the HP-400C meter on a high range (300 volt).

c. Connect the red clip lead (+) from the HP-400C meter to TP-204 on Range Calibrator and the black lead (-) from the HP-400C meter to the Range Calibrator chassis.

d. Turn the HP-400C RANGE SELECTOR until a scale is reached that gives approximately center scale reading.

e. The ripple shall be less than 70 millivolts RMS.

f. Disconnect the HP-400C meter leads from the Range Calibrator under test.

g. Set Range Calibrator power switch to the OFF position.

h. Reconnect power cord from fan-deck assembly at J-103.

i. Replace instrument cover and turn power switch ON.

7-6. RADAR LOCK-ON.

a. Connect waveguide from RF Pulse Generator to Range Calibrator and X-Band Receiver (see figure 7-1 and 7-2).

b. Set RF Generator frequency as follows:

1. Turn POWER SET control to the maximum counterclockwise position.

2. Turn SELECTOR switch to the OFF position.

3. Set meter to zero with the METER ZERO control.

4. Set SELECTOR switch to the CW position.

5. Refer to calibration chart to find the frequency dial setting for 9.1 Kmc. Set frequency dial to this setting.

6. Peak the power meter reading by rocking the REPELLER control back and forth.

7. Turn built in frequency vernier SLOWLY until a dip is observed on the power meter. Adjust frequency meter to maximum power meter dip.

8. Note reading of frequency vernier and refer to calibration chart on front panel of RF Generator. Use linear interpolation to read between the chart readings.

9. If frequency is not $9.1 \text{ Kmc} \pm 50 \text{ mc}$, turn frequency dial slightly (clockwise to increase frequency) and repeat step 6 through step 9 until desired frequency is obtained.

10. Turn frequency vernier two turns from measured frequency.

11. Refer to calibration chart to find the power meter reading corresponding to 35 MW peak power. Set POWER SET control for this reading on power meter.

c. Set RF Generator controls as follows:

1. Set 1000 CPS-PRF switch to the PRF position.

2. Turn SELECTOR switch to the INT position.

3. Turn PRF control to the "400" position.

4. Turn PULSE WIDTH control to the "2.5" position.

5. Set RF Pulse Generator OUTPUT ATTEN control to the ZERO position.

d. Set Range Calibrator controls as follows:

1. Set RADAR-BEACON switch to the RADAR position.

2. Turn the LO COURSE TUNING control to the maximum clockwise position, then turn LO COURSE TUNING control counterclockwise one full turn.

3. Turn the LO ATTEN control to the maximum counterclockwise position, then turn LO ATTEN control eight turns clockwise.

4. Set the AFC-MANUAL switch to the MANUAL position.

5. Turn METER SELECTOR switch to the SIG-XTAL position.

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6. Turn the REFLECTOR control for maximum meter deflection.

7. Turn the LO ATTEN control for a .6 to .8 meter reading.

8. Set the AFC-MANUAL switch to the AFC position. The meter shall show approximately a two cycle fluctuation.

9. Turn the LO COURSE TUNING control slowly counterclockwise, while keeping the meter peaked with the REFLECTOR control, until the fluctuations on the meter cease.

10. Turn the LO COURSE TUNING control for a peak reading on the meter.

11. Turn the LO ATTEN control for a reading of .6 on the meter.

12. Set the AFC-MANUAL switch in the MANUAL position.

13. Turn the REFLECTOR control through its range. If there is more than one position of the REFLECTOR control that effects lock-on, choose the position of maximum meter deflection.

14. Set the AFC-MANUAL switch in the AFC position.

15. The meter shall read the same deflection as set in step 13.

16. If the meter reading in step 15 is not the same as in step 13, repeat step 9 through step 15.

e. Set RF Generator controls as follows:

1. Turn PRF control to the "2500" position.

2. Turn PULSE WIDTH control to the "4.0" position.

f. Repeat paragraph 7-6d, step 12 through 15.

7-7. MODULATOR CRYSTAL.

a. Connect a 50 microampere meter to the EXT MOD jack on the Range Calibrator.

b. A crystal current reading shall be indicated on the 50 microampere meter. If there is no crystal current reading, replace modulator crystal.

c. Remove 50 microampere meter from the EXT MOD jack on the Range Calibrator.

7-8. EQUIPMENT SET-UP FOR DELAY MEASUREMENT.

a. Set oscilloscope controls as follows:

1. Turn TRIGGER SELECTOR switch to the "+" EXT position.

2. Turn VERTICAL INPUT selector switch to the INPUT NO. 1 position.

3. Turn SWEEP TIME switch to the "1.0" position.

4. Turn SWEEP TIME MULTIPLIER control to the "4.0" position.

5. Set VERT DEFL SENS switch to the mark between 3.0 and 1.0.

b. Set RF Generator controls as follows:

1. Turn PRF control to the "3000" position.

2. Turn PULSE WIDTH control to the ".25" position.

3. Turn POWER SET control to the maximum counterclockwise position.

4. Set SELECTOR switch to the CW position.

5. Refer to the calibration chart to find the frequency dial setting for 8.75 Kmc. Set frequency dial to this setting.

6. Peak the power meter reading by rocking the REPELLER control back and forth.

7. Turn frequency vernier SLOWLY until a dip is observed on the power meter. Adjust frequency vernier to maximum power meter dip.

8. Note reading of frequency vernier and refer to calibration chart on front panel of RF Generator. Use linear interpolation to read values between the chart values.

9. If frequency is not 8.75 Kmc $\pm$ 50 mc, turn frequency dial slightly (clockwise to increase frequency) and repeat step 6 through step 8 until desired frequency is obtained.

10. Turn frequency vernier two turns from measured frequency.

11. Refer to calibration chart to find the power meter reading corresponding to 35 MW peak power. Set POWER SET control for this reading on the power meter.

12. Set SELECTOR switch to the INT position.

13. Set EARLY SYNC switch to the "+" position.

c. Connect a coaxial cable from the LATE SYNC jack on the RF Generator to the INPUT NO. 1 terminals of the oscilloscope.

d. Connect a coaxial cable from the EARLY SYNC jack on the RF Generator to the TRIGGER INPUT terminals of the oscilloscope.

e. Turn the PULSE DELAY control on the RF Generator until a pulse appears on the scope at the 1.0 cm mark on the face of the oscilloscope.

f. Disconnect coaxial cables from the RF Generator to the oscilloscope.

g. Connect equipment as follows: (See figure 7-1 and 7-2).

1. Connect coaxial cable from the LATE SYNC connector on the RF Generator to the STC terminals on the X-Band Receiver.

2. Connect coaxial cable from the LINE VIDEO connector on the X-Band Receiver to the INPUT NO. 1 connector on the oscilloscope.

3. Connect coaxial cable from the UPM-11 VIDEO connector on the X-Band Receiver to the INPUT NO. 2 connector on the oscilloscope.

4. Connect coaxial cable from the EARLY SYNC connector on the RF Generator to the TRIGGER INPUT terminals on the oscilloscope.

h. Turn SWEEP TIME MULTIPLIER control on the oscilloscope to the "4.0" position.

i. Repeat paragraph 7-6d (lock-on).

j. Set X-Band Receiver controls as follows:

1. Turn LO TUNE control to the maximum clockwise position.

2. Turn A GAIN control and B GAIN control to three o'clock on front panel of X-Band Receiver.

3. Turn REPELLER FINE control to the center of its range.

4. Set STC TIME switch to the SHORT position.

5. Turn LO TUNE control to the maximum clockwise position. Then turn LO TUNE control one-fourth of a turn in the counterclockwise direction.

6. Turn REPELLER COURSE control to give the highest reading on the XTAL CURRENT meter. If the highest current reading occurs at the extreme limit of the REPELLER COURSE control, turn the REPELLER COURSE control in the opposite direction until the first peak is reached on the XTAL CURRENT meter.

7. Turn the LO ATTEN control to read .6 on XTAL CURRENT meter.

8. Slowly turn LO TUNE control counterclockwise, while maintaining peak crystal current with REPELLER COURSE control, until a pulse appears on the oscilloscope.

9. Turn REPELLER COURSE control for a peak crystal current reading.

10. Readjust LO TUNE control for a peak pulse on the oscilloscope, readjust LO ATTEN control for a reading of .6 on XTAL CURRENT meter.

11. Repeat step 9 and step 10 until the peak pulse amplitude and peak XTAL CURRENT coincide.

NOTE

At this point, it should be possible to go through peak pulse amplitude with the REPELLER FINE control and have little or no variation of XTAL CURRENT.

12. Turn CHANNEL SELECTOR switch to the A position.

13. Turn REPELLER FINE control for a peak reading on the GAIN SET meter.

14. Set STC TIME switch to the LONG position. A pulse train shall appear on the oscilloscope.

15. Set STC TIME switch to the SHORT position. If a single long pulse appears, repeat tuning procedure step 1 through step 15.

7-9. DELAY MEASUREMENT.

a. Set AFC-MANUAL switch on the Range Calibrator to the MANUAL position.

b. Turn oscilloscope INPUT SELECTOR switch to the INPUT NO. 2 position.

c. Turn the REFLECTOR control on the Range Calibrator for peak pulse amplitude on the oscilloscope.

d. Turn CHANNEL SELECTOR switch on the X-Band Receiver to the A position.

e. Turn the A GAIN control to read "30" on the GAIN SET meter on the X-Band Receiver.

f. Unlock carriage and probe of slide screw tuner.

g. Turn probe of slide screw tuner to maximum clockwise position.

h. Turn probe of slide screw tuner 10 turns in the counterclockwise direction.

i. Slide carriage of slide screw tuner while watching the GAIN SET meter on the X-Band Receiver for a rise or dip.

j. If no rise or dip is observed on the GAIN SET meter, turn probe one turn counterclockwise and repeat step i.

k. Repeat step i and step j until sliding the carriage at the slide screw tuner will produce a rise or dip on the GAIN SET meter which will read approximately "30" on the GAIN SET meter.

l. Lock probe and carriage of slide screw tuner at a reading of "30" on the GAIN SET meter.

m. Turn the REPELLER FINE control on the X-Band Receiver for a peak reading on the GAIN SET meter.

n. Turn the CHANNEL SELECTOR switch on the X-Band Receiver to the B position.

o. Turn B GAIN control to read "30" on the GAIN SET meter.

p. Slowly adjust REFLECTOR control on the Range Calibrator for a peak reading on the GAIN SET meter on the X-Band Receiver.

q. Turn B GAIN control to read "30" on the GAIN SET meter.

r. Turn CHANNEL SELECTOR switch on the X-Band Receiver to the A position.

s. Turn A GAIN control to read "30" on the GAIN SET meter.

t. Turn CHANNEL SELECTOR switch on the X-Band Receiver to the B position.

u. Turn B GAIN control for a reading of "30" on the GAIN SET meter.

v. Repeat step r through step u until both A and B channels read "30" on the GAIN SET meter.

w. Set CHANNEL SELECTOR switch on the X-Band Receiver to the DELAY position.

x. Turn DELAY IN YARDS switch to give peak meter indication on GAIN SET meter.

NOTE

It may be necessary to turn CLIP LEVEL control to keep the peak meter reading on the GAIN SET meter at a reading of 30.

y. The reading on the DELAY IN YARDS dial is the measured delay of the RANGE CALIBRATOR under test and should be the same as marked on the front panel tag of the Range Calibrator.

7-10. RANGE CALIBRATOR RETURN PULSE TRAIN.

a. Turn SWEEP TIME switch on oscilloscope to the "1.0" position.

b. Set STC TIME switch on the X-Band Receiver to the LONG position. Two pulse trains will appear. The one due to the Range Calibrator may be identified by setting the IF SIG switch on the Range Calibrator to the OFF position. One trace on the oscilloscope will leave.

c. Set Range Calibrator power switch to the OFF position.

d. Remove Range Calibrator Chassis from the instrument case (see paragraph 7-3b).

e. Remove standard delay line from the Range Calibrator and replace it with the original delay line.

f. Replace Range Calibrator instrument Case.

g. Set the Range Calibrator power switch to the ON position. Allow a ten minute warm-up period for the Delay Line.

h. Set the INPUT SELECTOR switch on the oscilloscope to the "2" position.

7-11. BEACON REPLY FREQUENCY.

a. Set the Range Calibrator controls as follows:

1. Set RADAR-BEACON switch to the BEACON position.

2. Set MANUAL-AFC switch to the AFC position.

3. Set IF SIG switch to the ON position.

b. Set RF Generator controls as follows:

1. Turn PRF control to the "3000" position.

2. Turn PULSE WIDTH control to the ".25" position.

c. Re-establish proper lock-on as outlined in paragraph 7-6d. If the Range Calibrator does not want to lock-on to the RF Generator, increase PRF control slowly until lock-on is obtained.

d. Set the RADAR BEACON switch on the Range Calibrator to the BEACON position.

e. Set controls on the X-Band Receiver as follows:

1. Turn LO TUNE control to the maximum counterclockwise position.

2. Set STC TIME switch to the SHORT position.

3. Turn LO TUNE control three and one-half turns in the clockwise direction.

4. Turn REPELLER FINE control to the center of its range.

5. Turn REPELLER COURSE control to read maximum on XTAL CURRENT meter.

6. Turn A GAIN control to 1.0 o'clock and B GAIN control to 3.0 o'clock.

7. Adjust LO TUNE control slowly counterclockwise until a pulse appears on the oscilloscope. Adjust LO TUNE control for maximum pulse amplitude on the oscilloscope, while keeping the crystal current peaked with the REPELLER COURSE control.

8. Turn LO ATTEN control to read .6 on XTAL CURRENT meter.

9. Set STC TIME switch to the LONG position.

10. If a pulse train is observed in the oscilloscope, return STC TIME switch to the SHORT position. If a single pulse is observed, repeat step 1 through 10.

11. Disconnect 7 inch solid waveguide section and replace with a PRD 559-B precision cavity.

NOTE

The cavity is a delicate instrument and should be handled with care.

12. Set cavity to approximately 9300 mc.

13. Slowly tune the cavity in the clockwise direction until peak pulse amplitude is observed on the oscilloscope.

NOTE

Should it be necessary to rock cavity tuning to obtain peak pulse amplitude on the oscilloscope, always end up with the last cavity motion in the clockwise direction.

14. Read cavity dial and apply correction to the reading as indicated by the cavity calibration chart. If cavity reads 9390 mc, the receiver is tuned to the wrong frequency. Re-adjust LO TUNE control in the clockwise direction until a pulse appears on the oscilloscope. Turn REPELLER COURSE control for peak crystal current.

15. The beacon reply frequency must be 9310 ± 3 mc as read on the corrected cavity.

16. Remove cavity from waveguide and replace the 7 inch solid waveguide section.

f. Set the Range Calibrator power switch to the OFF position.

g. Remove the polarized AC power plug from the Range Calibrator.

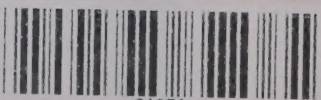
h. Replace the rubber receptacle cap on the Range Calibrator.

i. Remove the waveguide connection to the Range Calibrator.

j. Turn RF Generator variable attenuator to the "100" position.

k. Set the B+ and power switch on the X-Band Receiver to the OFF position.

l. Set the oscilloscope and RF Generator power switches to the OFF position.



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